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CONTENTS
VOLUME 23 · JULY-DECEMBER 1958

JULY 1958

AUGUST 1958

SEPTEMBER 1958

OCTOBER 1958

NOVEMBER 1958

DECEMBER 1958

THE EMERGENCE OF VISION IN THE ANIMAL WORLD

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TO BE INVITED to give the Lister Oration is indeed a unique experience which comes once in a life-time, and that to few. Like all experiences worth having, it is charged with emotion : at first a thrill of pride, for what surgeon—and of all surgeons what British surgeon ; and of British surgeons, what surgeon trained in the Scottish universities where Lister did his essential work—could fail to be flattered that he had been chosen to keep that memory officially alive ? But after pride the fall ; for what orator, confronted with a task of such responsibility, could fail to be overwhelmed by a sense of inferiority ? For today we commemorate the life's work and the character of a giant among men.

There have been indeed few men who have created a complete revolution in the philosophy and practice of the branch of knowledge to which they had dedicated themselves, who have thrown a bridge across a great divide on the way to understanding, that journey without end, so that men could say " this is indeed a new world " as surely as, on a greater and higher plane, the history of Christendom is divided into two epochs—before and after Christ. In such a way in cosmology, Copernicus, watching the heavens from the shores of the Baltic Sea, overturned the system of Aristotle and Ptolemy by transferring the centre of the universe from the earth to the sun ; in such a way in natural philosophy, Francis Bacon, in England, displaced the authoritative traditions of the classical scholars by stressing the importance of the experimental method in the acquirement of knowledge. Similarly in physics there was a pre-Newtonian and a Newtonian era ; in biology a pre-Darwinian and a Darwinian ; in medicine a pre-Harvean and a Harvean ; and in surgery a pre-Listerian and a Listerian. It is curious, incidentally, how many of these revolutionaries were English.

In each case, each branch of knowledge had stood still since its first awakening in the river-civilizations of the Ancient World and its crystallization in the glory of classical Greece ; in each case a prophet arose who, partly by the inspiration of that curious something we call genius, but largely by force of character and unremitting labour over many years, transformed a science by substituting for the sterility of the past a completely new vision for the future. Each of them had to fight a battle alone in the face of prejudice, ridicule and often obloquy ; but such glory as was theirs is not to be shared.

To this generation pre-Listerian surgery is a thing of history ; none of us here has seen its horrors or experienced the revolution he accomplished.

And so I think in this lecture, founded to commemorate his achievemer t, it is well to stop for one moment that we may remind ourselves of i.s greatness. It can truly be said that, before Lister, the results of surgery in the middle of the last century were little better than in the days of Hippocrates ; probably in Lister's early days it was worse than it had ever been, partly because the recent introduction of anaesthetics was tempting surgeons to undertake techniques which the unanaesthetized patient could not tolerate, and partly because the industrial revolution had stimulated a remarkable increase in the population of these islands, particularly in the towns, so that in the cramped and insanitary hospitals the opportunities for cross-infection had increased manyfold. An operation was a procedure to be adopted only as a last desperate resort, for a pin-prick served as the gate of death ; to open the abdomen, the chest or the head was unthinkable. A surgical hospital was a charnel house from which only the fortunate few emerged.

That was pre-Listerian surgery. That today we can at leisure and almost with nonchalance explore every cavity and recess in the body, that our techniques are limited not by fear but by ingenuity, that today a hospital is a Gate of Hope, the cleanest and often the happiest place in a community—all that is due to Lister. By his work in his life-time, and by the continuance and extension of his teaching after his death, he has eased more pain and suffering and saved more lives a thousand-fold than have been lost in all the battles since there were records of war. Surely a legacy to mankind worthy of a commemorative lecture ; but as surely an achievement to make any lecturer despair of doing it justice.

In view of the fact that Lister's great contributions to surgery and humanity stemmed from his capacity to see beyond the confines of the technical aspects of surgery to the new world of micro-organisms, at that time being brought to notice by Pasteur, instead of telling you of some of the technical aspects of my particular craft—and probably boring most of you thereby—I am going to ask you to explore with me the animal world. When, in 1877, Lister left Scotland to return to London to convert the English, all the surgical world assembled at King's College for his inaugural lecture agog to hear—and certainly to criticize—the latest contribution to his new technique. But for some months previously Lister had been interested in the curdling of milk, and instead of surgery he gave them a dissertation on the *Bacillus lactis* he had discovered, proving the part it played in this phenomenon.

I am therefore taking a leaf out of Lister's book and bringing you to a non-surgical world—albeit a world full of interest and delight, and importance. It is indeed a fascinating subject—this story of how animals came to see ; and then, having seen, of what they see ; and, more intriguing still, of what they make of this world we share with them. And it is important ; for the faculty of vision was probably the greatest single factor in the evolution of man. Although we are highly visual creatures,

2

Olfactory
lobe   Optic lobe

THE NOSE—BRAIN
of a reptile

Visuo-motor

Visual
sensory
and
association
areas

(HAND)

SPEECH

THE EYE—BRAIN
of man
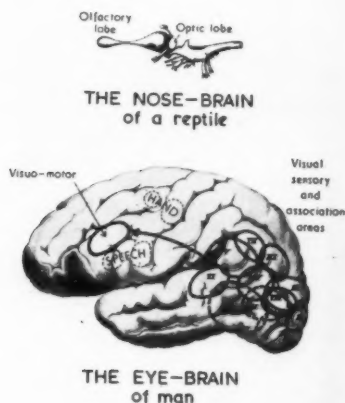
Fig. 1.

this does not apply to the lower animals. Most of them, indeed, depend primarily on other senses rather than on sight—initially, in the more primitive creatures, on the chemical and tactile senses, and in the later stages of evolution, on the extensions therefrom into the senses of smell and hearing.

In the lower vertebrates the sense of smell is the most fundamental sense and the fore-brain has an olfactory function ; vision is a subsidiary sense, relegated to a small and obscure place in the mid-brain (Fig. 1). Not until mammals are reached is vision translated from the mid-brain to the cerebral cortex, until in primates vision comes to dominate the entire brain with its receptive centre behind, its wide contiguous association areas, and its motor and coordinative regions flung forward in the frontal lobe, the seat of intelligence, close to the centre for the control of the hands. In this way sensory reception becomes vision in thought and action, and the roving eyes and the exploring fingers could combine with intelligence to unravel the secrets of the world. It was this process of ousting the sense of smell as a primary determinant of behaviour, this transfiguration of the nose-brain to the eye-brain, that constituted the greatest single factor in assuring the dominance of man and establishing his physical dexterity and his intellectual supremacy. This it was essentially that gave him power to attain new skills, and, by opening up a fuller understanding and appreciation of the meaning of the outside world, it provided a potent stimulus for the fuller development of every part of the brain.

In an attempt to analyse the visual appreciation of animals, let us start where every schoolboy starts—with the lowly amoeba. In order to obtain

3

a supply of fresh nourishment in the water wherein it lives, an amoeba periodically throws out pseudopodia, an activity due to physical changes in the gelation of its surface layer. If a pseudopod encounters something noxious, the surface layer gelates, the pseudopod stops, protoplasmic flow starts in the reverse direction and the amoeba travels away from an environment that is unsuited to it (Fig. 2). This is effected by light. The same gelating effect on the surface layer is produced by mechanical stimulation, by chemical substances, or by heat ; but the interesting thing is that these effects are not specific ; each of these stimuli produces the same response, and since it has been recently shown that they are additive, in the sense that when two are applied simultaneously in subliminal concentrations so that neither would have an effect acting alone, the one reinforces the other and a response is produced. It would seem to follow that in this organism there is no specific response to light or any other sensory stimulus, but merely an indiscriminate reactivity of a general nature to them all. This curious one-dimensional world, this flatland of sensation wherein the senses as we know them—for example vision and touch—are similar and additive, seems to me quite fascinating and intriguing.

From out of this primitive reactivity the various senses have become differentiated in evolutionary history. Alone, the thermal sense has shown no evolutionary off-shoots. From chemical stimulation has developed the fundamental sense of smell and its cousin, taste ; from the response to mechanical agitation has developed the sense of touch and the vibratory sense with its extension to the sense of hearing ; from photo-sensitivity has developed vision.

There may be other senses of which we have no conception. It could well be argued that termites or the blind driver ants of Africa must have
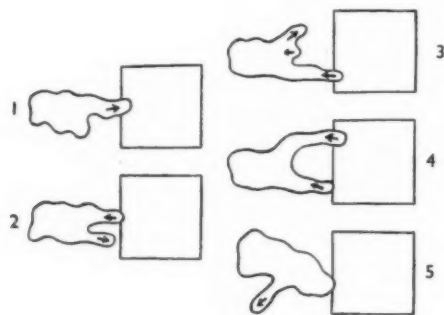
Fig. 2. The behaviour of the amoeba.
The organism is moving onto the illuminated cover-glass of a microscope and eventually its movement is reversed (after S. O. Mast).
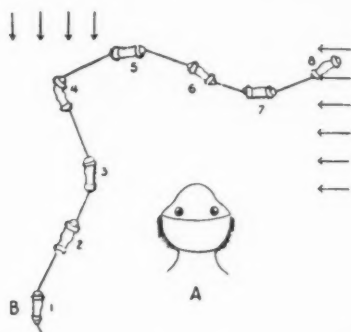
Fig. 3. The response of the larva of *Arenicola*.

a) The head of the larva with two symmetrical eyes. (*b*) The path of movement of the larva : in 1 to 4 the light is shining from above ; in 5 to 8 it is placed at right angles (after S. O. Mast).

some such faculty. They have no eyes ; but the complexity of their social life in their teeming underground cities, not only as an ordered routine but with coordinated variations to meet unexpected emergencies of construction or war with equal facility, as well as the regimented discipline of their forays in the outside world, seem to demand some means of communication of which we know nothing, and perhaps can never know anything if it has no basis in our experience.

Let us now return to vision. To some extent the matter is speculative ; but there seems little doubt that it was essentially from the primitive motor response to light that vision initially developed. It was eventually employed purposefully for the avoidance of obstacles and enemies and the pursuit of food.

This most primitive reaction we have seen in the amoeba. We find similar but more elaborate responses as we ascend the animal scale. Thus the green flagellate, *Euglena*, swims in a general sense away from a source of light ; the finger-like larvae of the polychaete worm, *Arenicola*, towards it (Fig. 3). In a further step forward the animal travels not directly towards or away from a light, but maintains a constant angle to it (Fig. 4). This is an important advance wherein light does not act merely as a stimulus attracting or repelling the animal into a more favourable environment, but can be used as a means to an end, guiding it to a place where it wishes to go ; the animal thus puts itself in the position of the pilot of a ship who can steer otherwise than directly in line with the sun or the pole-star.

Incidentally, in artificial circumstances this may have serious consequences. If the guiding light is sufficiently far away as is the sun, the path
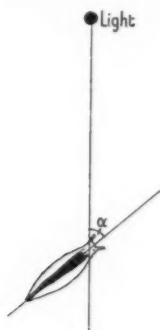
Fig. 4.   The orientation of a mollusc with respect to light.
α is the orientation angle which the longitudinal axis of the mollusc makes with
with the direction of the light (after Fraenkel).

of the insect is virtually a straight line ; but if it is near at hand and the
angle of incidence is to be kept constant, the insect must perforce fly
along a logarithmic spiral ending in the light itself.   It is for this reason
that the moth, utilizing a mechanism designed for reference to the sun,
flies to its death in a candle flame.

This directional taxis to light may reach astonishing accuracy.   We shall
take two examples of it as it is seen in insects and birds.

The compound eye of insects is ideally constructed for a function of
this type.   It is composed of a multitude of separate elements called
ommatidia (Fig. 5).   As a ray of light passes from one to the other
stimulating each at a time, the insect turns itself to maintain the constant
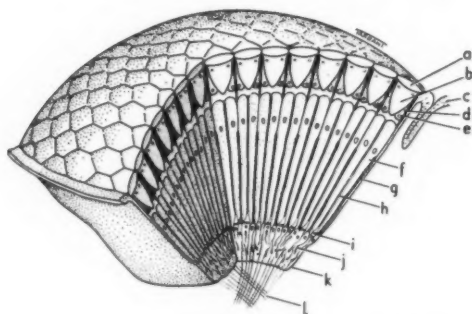
Fig. 5.   Diagram of a compound eye of an insect with a sector excised.
(*a*) corneal facet ; (*b*) crystalline cone ; (*c*) surface epithelium ; (*d*) matrix cells
of cornea ; (*e*) iris pigment cells ; (*f*) cell of retinule ; (*g*) retinal pigment cell ;
(*h*) rhabdome ; (*i*) fenestrated basement membrane ; (*j*) nerves from retinular
cells ; (*k*) lamina ganglionaris ; (*l*) outer chiasma.

6

stimulation of one element. By blacking out different portions of the eye with varnish, it can be shown that the entire mechanism acts reflexly and automatically.

As an illustration the behaviour of the ant is interesting as it returns from far distances laden with food to its nest, a feat quite astonishing in an insect apparently lost in a forest of grass. The Swiss biologist, Santschi (1911), proved that it guided itself by the sun. If he shaded the insect from the direct light of the sun and reflected its rays from the opposite side by a mirror, the ant immediately reversed its direction. The German biologist, Brun (1914), went a step further. As the ant was going back to its nest, he imprisoned it in a box for two and a half hours, during which time the sun had traversed an angle of 37 deg. in the sky ; on being released the ant resumed its path still maintaining the same angle but now to the afternoon sun and therefore travelling in a direction deviated by 37 deg. from its nest which, of course, it never reached (Fig. 6).
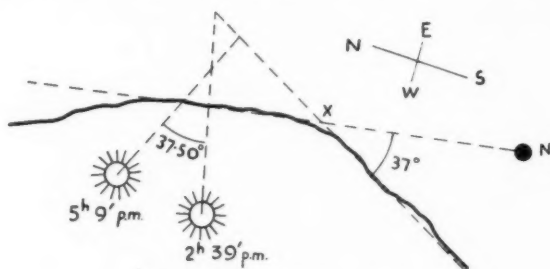
Fig. 6. The orientation of the ant.
The dark line indicates the route taken by the ant towards its nest, N. The initial part of its journey was orientated at an angle of about 90 deg. to the sun. At X the ant was imprisoned in a box for two and a half hours, during which time the sun traversed an angle of 37·5 deg. On its release the ant resumed its path, again at right angles to the sun, deviating from its former path by an angle of 37 deg. (after Brun).

von Frisch (1948-54), the delightful Austrian naturalist who has spent a long life in these studies, showed that bees are still more clever and do not make the same mistake. They appear to be possessed of an internal time-clock, as it were, in the brain, corresponding to the diurnal rhythms which occur in many animals and man. Not only can they, like the ant, orientate themselves with great accuracy by the sun, but they can, unlike the ant, make a correction according to the time of day. von Frisch, for example, accustomed a hive of bees to seek a feeding place 180 metres away in a direction 30 deg. N. of West during the afternoon (Fig. 7). One morning he transported them to a hive in a different landscape and released them. The vast majority of the bees went to a feeding place 180 metres away, still in a direction 30 deg. N. of West, ignoring three other symmetrically placed sites. To retain the same orientation guided by the

7
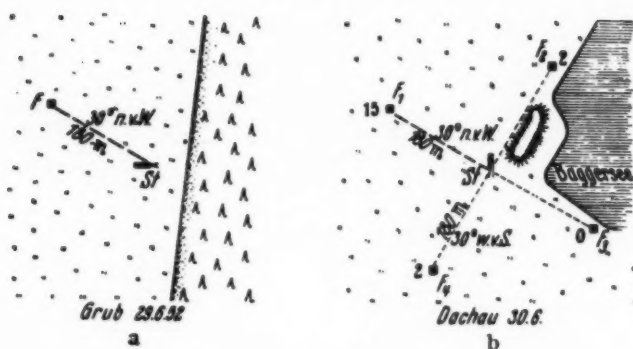
Fig. 7. The displacement test in the orientation of the bee.
In (a), marked bees from a hive, St, were allowed to feed in the afternoon from F.
In (b), they were transported to an unknown landscape and allowed out in the
morning. Fifteen bees fed at a feeding place F_1, 180m. away in the direction
30 deg.N. of West. Relatively few (2, 0, 2) went to three alternative feeding places
F_2 to F_4 (after K. von Frisch).

sun, the bees must have been able to calculate and allow for the solar
movements with time, and the difference in the sun's direction in the after-
noon and the morning. This is an extraordinary feat when it is remembered
that the brain of a bee is only one tenth of an inch in diameter ; neverthe-
less, it is accomplished.

The navigational ability of birds is still more extraordinary ; indeed,
their capability of undertaking migrational flights from one continent
to another to return to precisely the same locality has excited admiration
and conjecture for centuries—from Africa, perhaps, to the same tree or
the same loft in England. This apparently incredible faculty has recently
been investigated by Matthews of Cambridge (1951-55). Among other
experiments, he took the Manx shearwater to America and released it
there. On an overcast day the birds flew indiscriminately in all directions,
completely lost. On a sunny day, as they soared to fly, the birds orientated
themselves correctly within forty seconds, and homed 3,050 miles across
the trackless Atlantic wastes to arrive after twelve and a half days, each
in its own particular burrow on a small island off the west coast of England.

Consider for a moment what this means. The bird's eye is the most
elaborate of any animal type, capable of resolution to ten seconds of arc;
that is, with some six times the accuracy of the eye of man. Matthews
found that by keeping the birds in conditions wherein sun and light were
excluded, constant errors in the flight home were made which could only
be explained if the birds were failing to correct for the variations in the sun's
altitude from which they derived their measure of latitude. By de-synchro-
nizing the day-night rhythm before release by experimentally arranging
an artificial day starting some hours earlier or later than usual, errors in

8

longitude could be explained by postulating a disturbance of an inherent time-sense based on regular day-night sequences. The only explanation would seem to be that these birds can orientate themselves by estimating the sun's arc over a short distance and from this extrapolating its position at local noon, comparing this position with the remembered position at home, and making corrections according to a twenty-four-hour rhythm maintained by a reference system (an internal clock) in the brain. All this certainly sounds fantastic particularly applied to a creature with a proverbially small brain ; but the ability of a bird released in America to orientate itself so rapidly for a flight to a very precise locality in England, is fantastic.

We have seen that the primary effect of light on the eye is the control of movement, and we have indicated the extraordinary lengths to which this potentiality may develop. We must now enquire to what extent are these motorial reactions automatic and reflex, and what part visual perceptions play in them. We know that the bird can see and that the bee can see, but in these reactions do they appreciate what they see ? It is unlikely, for example, that the bird knowingly performs complicated mathematical extrapolations such as would appal most of us. Such a reaction as we have described must be instinctive and automatic.

But does the amoeba see as it moves towards or away from a light ? We can go further, for these motor reactions are not confined to the animal kingdom. You remember that Carl Linnaeus, the botanist of Uppsala, who in his world-famous garden, still kept with reverent care by the Swedes, noticed the regular opening and closing of the flowers— the poppy which opened at 6 a.m., the speedwell at mid-morning, and so on. These you may say, are slow and static ; but does speed matter ? The Bengal plant, *Hedysarum girans,* nods actively to a passing cloud. If we suppose that the clams see when they withdraw their siphons, or the snails their tentacles in the light, are we also to suppose that this applies to the plants which open their petals to the morning sun ?

This is a question which is indeed difficult to answer. In the simple philosophy of Aristotle and for 2,000 years thereafter, no argument arose ; plants had a vegetative soul responsible for growth and repro- duction, to animals was added a sensitive soul governing movement and sensation, and to man a rational soul. But doubts began to occupy men's minds in the seventeenth and eighteenth centuries in the long disputation between the Cartesians who followed Descartes, and the mystic German nature-philosophers who talked of " vital force," the disciples of Paracelsus in the classical tradition, who found philosophical expression in Leibnitz and Goethe. To the first, the universe was essentially mechanical, driven automatically according to mathematical laws ; to the second not only all living creatures but also minerals were permeated by a directive vital force. A middle view was expressed by Lamarck towards the end of the eighteenth century, who claimed that the lowest organisms were

9

insensitive and that their conduct was governed by external driving force s derived from the environment ; but as the evolutionary scale was ascended, organisms generated their own appreciation to a progressively greater degree until vertebrates were reached, at which stage intelligence became possible.

Each of these views has been maintained in recent times ; the simple reflexology represented by Loeb and the Russian school of Pavlov on the one hand, and the purposive view represented by such philosophers as Whitehead, McDougall and Russell on the other, a view wherein the vital force of the ancients has been replaced by the equally vague concept of the " general drive " or " action-energy " of modern biologists.

The mechanistic view would place the emergence of visual reflexes into the plane of consciousness as a late development. This attitude found its modern apostle in the person of Jacques Loeb. To him all the orientating and instinctive reactions of the lower animals to light or other stimuli were mechanically determined. Although it seemed to respond voluntarily and often purposively, the movements of a phototactic animal were those of a robot ; it is forced to go where it is taken by its reflexly driven cilia, legs or wings, an activity in which consciousness or vision has no place. Even an ant, with all its proverbial intelligence, orientates it journey to light unthinkingly as does a sleep-walker or an automaton, and in this respect is as unteachable as a machine, completely totalitarian and incapable of individual adjustment.

It must be remembered that the new science of cybernetics has demonstrated that similar reactions, sometimes of astonishing complexity, can be carried out by non-vital mechanisms, those curious electromechanical first cousins of computing machines, which by a combination of photocells, amplifiers, motors and automatic governing devices, can simulate many of the reactions of living things, not in appearance but in behaviour, as they navigate themselves round the play-room of the electronic engineer. Figure 8 illustrates such a creation of Gray Walter of Bristol. Such mock-biological robots, goal-seeking and self-regulatory, capable of the storage of information and possessed of a rudimentary type of memory maintained by electrical oscillations, have been constructed so that they can explore their environment with an apparent purpose. A photo-cell can serve as a receptor, and amplifiers and motors can be inter-connected in such a way that a positive taxis (for example) to a moderate light, and a negative taxis to a bright light (or to material obstacles or gradients, and other things) can endow it with the faculty to discriminate between effective and ineffective behaviour, to seek actively an environment with moderate and optimal conditions, to acquire conditioned reflexes, and even to perpetuate its activity and " feed " itself with electricity by being optically attracted to a charging circuit when its batteries begin to fail. And if things go ill, just like an animal and more like a man, it will work itself into a state of hysteria.
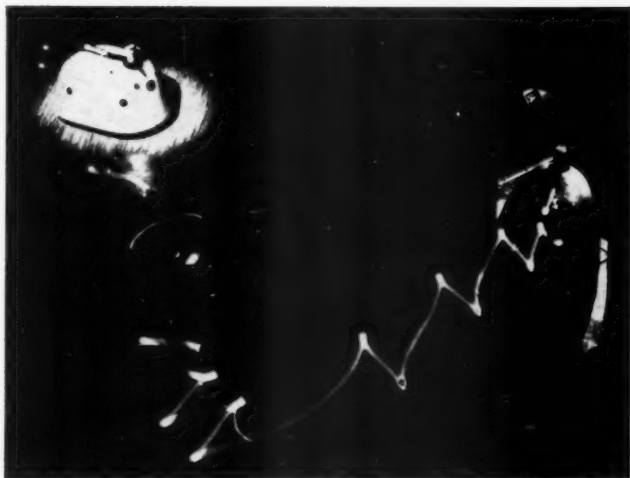
Fig. 8.   A cybernetic robot, avoiding a stool and making for the light (Gray Walter)

On the whole, however, it would seem that the matter is not so simple as this materialistic view would suggest. There is no doubt that to the higher animals vision is an act of perception, a mental as opposed to a reflex process, not merely an inevitable and automatic response but something which includes an element of appreciation and purpose and can be modified by experience. To decide when automatic reflexology became translated into perceptive appreciation, when mechanism first became interwoven with teleology, we must, I think enquire when visual sensations can first be shown to modify conduct not in an automatic but in a purposive and intelligent way.

The most acceptable experimental procedure wherewith to analyse these reactions is a maze or discrimination box (Fig. 9). The animal is allowed to go from the lower (outer) chamber into an inner compartment where two choices await him. At the far end of each are two visual stimuli, lights varying in intensity, perhaps, or colour ; with one is associated a reward (such as food), with the other punishment (such as an electric shock). The object of the exercise is to see whether the animal can be trained to differentiate the one light-stimulus from the other while all other factors are kept constant. The method, of course, like all experimental techniques, has its limitations. The mere isolation of the stimulus, for example, is outside the animal's natural experience and forms an artificial environment, while the experiment may well break down if visual stimuli are not of importance in its life, so that they do not excite interest. Moreover, such experiments are limited to animals which are

11
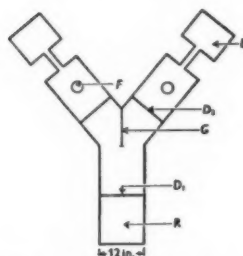
Fig. 9.   Discrimination box.
L, light box ; F, food ; D₁, hinged door ; D₂, hinged door with 3in. by 3in. opal glass panel ; G, glass partition ; R, restraining chamber (R. Gunter).

amenable to training, consistent in their behaviour and relatively intelligent and docile in their disposition, for it is impossible to train a stupid animal or one that gets cross or sulks.

In this way it has been shown, for example, that the cockroach, which normally avoids light, can be conditioned to go straight—and unnaturally —towards it, provided that it has been taught that a dark and comfortable shelter lies underneath it.   Purposeful appreciation and experience can thus alter completely the automatism of the response, and indeed reverse it.   It would seem impossible that an animal be trained visually to modify its conduct unless it can remember a previous visual experience, unless this experience had imprinted itself upon its consciousness, unless, in fact, the stimulus of light had given rise to a perception.

Where do such experiments take us ?   All investigations of whatever type so far undertaken have shown that in the three most primitive classes of animals—in protozoa, coelenterates such as jellyfish, and echinoderms such as the starfish—all responses to light are completely automatic and fixed.   The first group in evolutionary progress to show some degree of visual intelligent appreciation is the worms.   The earthworm has a great number of tiny simple eyes underneath the skin concentrated mainly at the head-end, and to some extent at the tail.   In dim illumination it goes towards the light ; in bright illumination it avoids the light.   It follows that on emerging from its burrow at any time except at night or in the dim twilight of morning or evening, it will at once retract back into its burrow.   Almost a century ago Darwin recognized that worms had a modicum of intelligence, for he noted the deft way in which by trial and error, profiting by previous experience, they transported suitable leaves of various types to their burrow or collected little stones to guard its entrance.   We know that to the worm vision is relatively unimportant, for its life is dominated by its sense of touch and its exquisite sense of smell.   Nevertheless, in a maze, propelled forwards by a light from behind and rewarded by food in a dark cell or punished by an electric shock, earthworms or aquatic worms can be trained to respond

12

in different ways to light-stimuli and to acquire a complete reversal of their usual reactions.

The suggestion that worms were the first creatures to see may seem surprising ; but, indeed, it is not. For we see, not with our eyes but with our brains, and the world we see is a symbolic representation of the outer world created by the central nervous system. Animals lower than worms have no centralization of their nervous systems. Some protozoa have conducting fibrils in their cellular structure to coordinate the movements of their cilia. Coelenterates such as the hydra have a complicated nerve-net. The starfish has a higher nervous organization with trunk pathways, but it also shows no centralization. All these animals show no intelligence or awareness in their reactions, no ability to profit by experience, no understanding to modify their conduct. For the first time in evolutionary history a centralized ganglionated nervous system appears in worms (Fig. 10) and in them for the first time the responses to light are not
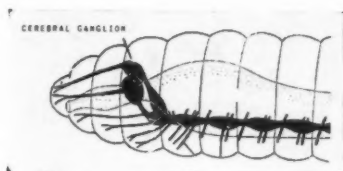
Fig. 10. The ganglionated nervous system of an earthworm.

entirely rigid and automatic, but are associated with motivation, incentive and appreciation, are capable of modification by experience and training. Vision, although still a secondary sense, for the first time becomes endowed with some degree of awareness and meaning : in short, the animal can see.

It is true that the amoeba may be imagined to experience some lowly kind of appreciation of light ; it may be aware of the change in its environment and even associate the change with sufficient affective tone to allow it to be appreciated as something pleasant or unpleasant. But this is by no means necessary. We know of many reflexes far more complex within ourselves of which we are quite unconscious ; and even if consciousness may be superimposed on them, it need not be necessarily or directly so. If some awareness does occur in the amoeba, we must logically surmise that this primitive sensation was part of a co-aesthesis in which the several senses as we known them are merged into one vague and indiscriminate unity in which stimuli—light, chemical, thermal, or tactile—which to us are distinct and unrelated, are co-equal and additive—but this is merely surmise, and for the surmise we have no basis in observed facts.

This is not to say, of course, that visual experiences at the lowliest level remotely resemble ours. The very simple eye of the worm cannot

form an image of anything : all it can do is to appreciate the differences in the intensity of light and perhaps the direction of its incidence. Its visual world can be merely one of light and shadow.

We have already seen that the primary response to light was the control of the animal's movement. There is little doubt that the next stage in visual evolution was the appreciation of movement in the outside world. This is a basic character, more primitive than the appreciation of form or colour. Let us ascend the animal scale from worms and come to molluscs. The scallop has a multitude of brilliant emerald-green eyes set like a diadem around its mantle. It makes no visual response to an object unless some movement is made ; having seen it, it makes no attempt at visual analysis. Any movement of any object excites the same response—a protrusion of the tentacles which are provided with organs of the more fundamental chemical and tactile senses ; these explore the object intelligently and on the results of their findings the animal either eats or flees. Likewise the snail, which has a simple eye perched at the tip of each posterior horn, appreciates light and movement. But vision is not of fundamental importance to it. In bright light or on stimulation, the eyes are retracted within the tentacles (Fig. 11). Safety is ensured by the extreme tactile sensitivity of these animals to the slightest movement of the air or to any jarring of the surface on which they crawl ; while food is sought almost by scent alone.
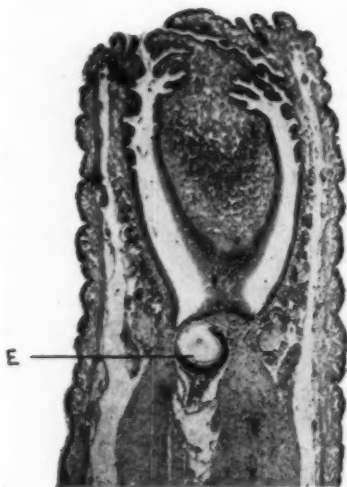
Fig. 11. The eye (E) of a snail retracted into the tentacle.

Even in the higher and more visually conscious animals, the appreciation of movement to a large extent dominates visual behaviour, just as in the human eye the periphery of the retina, the most primitive and least organized part, is specifically adapted for this purpose. The fly takes no notice of the hand outstretched to squash it so long as the hand does not move ; but on the slightest movement, the insect appreciates the danger and provokingly flies away. In the same way the rabbit will run into a stationary man, and a man is unseen to the wild animal as long as he remains motionless—and down-wind.

Form vision, or visual acuity, that is, the capacity to analyse and appreciate a pattern, is a later acquisition. The first proof we have of its existence is in the cephalopods, such as the octopus, creatures with eyes so well developed that they resemble those of man even although, as occurs in all invertebrates, they are entirely developed from the skin, not from the brain. In conditioning experiments wherein a particular figure was associated either with food or an electric shock, Boycott and Young (1950-56) of University College, showed that the octopus could be trained to differentiate between such formations as a cross, a square, or horizontal or vertical lines. The honey-bee can also be trained to feed from a sugar container placed beside a black disc and avoid one beside a black cross ; but the ability of insects to analyse a pattern is poor.

Colour vision is the last of the visual qualities to emerge, and it is of restricted incidence. Among invertebrates it has been proved to occur only in insects, which indeed, have a more extensive spectrum than we, for they see far into the ultra-violet. Several types of insect have been trained to feed or to refuse food associated with different colours ; and indeed, the economy would seem to be biologically wrong that induced the entire vegetable world apart from the cryptograms to luxuriate in the riotous colouring of the flowers unless the insects which feed on their honey and incidentally pollinate them could appreciate their extravagance. Among vertebrates colour vision occurs in some reptiles but has been shown to play an active part in behaviour only in fishes, birds and primates.

In tracing the development of the visual perceptions, as with all other functions, the most important determinant factor is found to be environment. To the animal which lives in the dark, vision is useless so that the eyes regress or even disappear. This applies to many of the inhabitants of the abyss of the oceans to which light does not penetrate, to fishes and amphibians which live in dark caves or burrow in mud, to creatures—termites and even mammals such as the mole—which burrow in the earth, and to internal parasites.

To animals which live upon the ground, vision has a biological value, but in the vast majority of cases it is a secondary sense. Most reptiles follow a trail, either of prey or their mate, by smell, the flickering tips of the tongue picking up odiferous particles from the ground and transferring them to Jacobson's organ in the mouth, where they are both smelt and

15

tasted. The blindfolded rattlesnake, for example, readily recognizes and viciously attacks its enemy the king-snake ; but, deprived of its tongue, an essential part of its olfactory mechanism, it lies passive even although it can see.

To most of the lower mammals—small creatures living close to the ground with a restricted horizon, often of nocturnal habits—vision is the fourth most important sense, the eye coming after the nose, the ears and the tactile vibrissae. In their furtive lives, both food and safety are attained essentially by keeping their noses to the ground. It is true that as mammals grew larger and stronger they felt able to roam abroad in the light of day, some relying for safety on their strength or ferocity, such as the carnivores, some on their fleetness, as the ungulates. In these, vision became more useful and the eye better ; but the brain remained a nose-brain and dramatic progress was impossible. Vision concerned itself essentially with moving stimuli, and visual analysis and colour vision are absent.

The bull, for example, is colour-blind, and the matador would excite the same wild response if, instead of his red cloak, he waved a piece of grey sacking so long as the bull sees something moving. Even the dog lives in a colourless world of grey monotones, its life dominated to a considerable extent by sounds which we cannot hear, for his hearing is
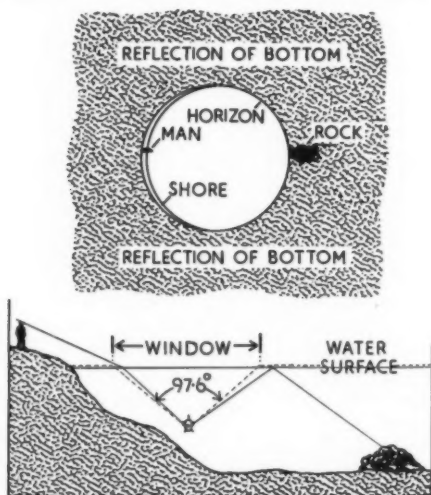
Fig. 12. The upper visual field of a fish.
In the lower figure the fish is seen swimming in fresh water and the paths of the rays of light are delineated.
In the upper figure is shown the view seen by the fish with the central circular window of aerial vision near the periphery of which bodies become progressively foreshortened ; around it is reflected a view of the bottom mirrored on the surface of the water (after G. Walls).

16

sixteen times more acute than ours, and scents of the acuity and diversity of which we have no conception ; his feeding is regulated by smell and, deprived of his nose, even the urges of sex are lost. That is difficult for us to realise in our state of comparative noselessness.

For vision to come into its own the freedom and spatial scope of a tri-dimensional environment seems necessary. This to some extent is seen in fishes. As an example of the excellent visual judgments obtainable in fishes, the performance of the archer-fish, *Toxotes jaculator,* may be cited. It must be remembered that a fish is at a disadvantage when looking upwards from water into the air. In these circumstances it must see through a window, outside which, owing to the total internal reflection of light, the bed of the stream is mirrored ; while within the window, because of the refraction of light at the water-air interface, objects out of the water become progressively foreshortened (Fig. 12). Nevertheless, the archer-fish, while swimming, will spit a jet of water at an insect flying three feet above the surface with astonishing accuracy, overwhelming it in the air and devouring it when it has been brought down to the surface. This involves not only an excellent visual acuity but an equally excellent sense of direction, of judgment and of distance (Fig. 13).
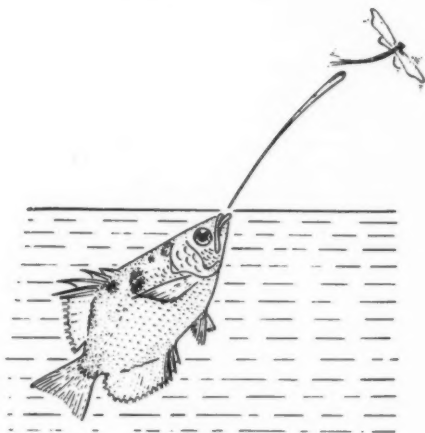
ARCHER—FISH

Fig. 13. The archer-fish shooting a jet of water at a dragonfly flying above the water.

Nevertheless, to the majority of fishes vision is a subsidiary sense, for most of them live happily and fully without vision although they normally use their eyes, their conduct being dominated by their chemo-receptors

17

and the vibratory organs of the lateral line. It is to be remembered that in all cases water is not a good medium for accurate vision, and in the abyss darkness is absolute. In the high lakes of the Alps, the fish are as well and prosperous-looking after the seven or eight months when the water is covered with a layer of ice and snow sufficiently thick as to preclude all light, as they do in the sunlit water during the short months of summer. Blind cave-fishes are as alert and well-fed as their sighted cousins, and in the aquarium artificially blinded rays or skates acquire their food and conduct themselves in a way indistinguishable from normal fish.

For the full development of vision animals had to get above the ground. In the air the adventure afforded by the third dimension, the necessity of distant exploration and the absence of other sensory stimuli such as smell or touch, all served this purpose. For this reason among invertebrates, insects have the highest visual powers and alone have a fully developed colour sense. Similarly among vertebrates birds attain the highest visual acuity and again have colour vision. The reactions of fear by the shrike which the falconer carried with him in a cage let him know the whereabouts of his bird-of-prey long after he himself had lost track of it in the sky ; and the African vulture will spot dead game lying on the ground, to us completely camouflaged by its surroundings—and recognize that it is dead—from a height of 4,000 metres, a height so great that a man cannot discern the bird in the sky with its three-metre wing-span.

Even among reptiles the arboreal types which get above the ground have excellent vision. In contrast to its cousin the ground-snake, the tree-snake has remarkable eyes, set forwards to attain binocular vision, each provided with a fovea ; it hunts with its eyes, not with its tongue. Among this class of animals the stimulus to vision of life in the trees is nowhere better seen than in lizards : the chameleon, for example, hunts for insects by vision. It is a sluggish animal, but its two eyes, standing out as it were on turrets, swivel around quite independently of each other looking for insects. As soon as one is seen in the vicinity, both eyes converge forwards upon it, and with incredible rapidity and unfailing accuracy, the long sticky tongue shoots out as far as the length of its body to capture its prey, a feat requiring excellent visual judgments.

But in all these classes a cerebral cortex is unavailable for visual appreciation so that their optical powers, excellent although they may be, are not fully realized. The cerebral ganglion of the insect is essentially dominated by rigid reflex reactions ; and in the brain of the bird visual appreciation is relegated to the tectum in the mid-brain, and although its optical imagery is the most perfect we know, a perceptual symbolism is lacking to match it (Fig. 14). Only in mammals does vision find cortical representation, and only when they left the prison-house of the ground did vision come into its own. This tendency is seen even in the family of squirrels, lowly rodents far down the scale in the mammalian class, which have excellent eyes.

VISUAL PATHWAYS AND BRAIN
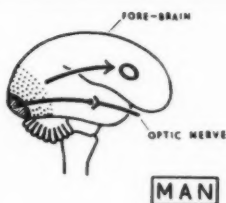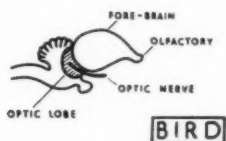
Fig. 14.

First in the tree-tops of the tropical rain forests every stimulus was presented in every variety, and most of all visual stimuli. The first creature to have a brain potentially capable of evolving into an eye-brain was our remote ancestor, the tree-shrew. The interplay of the tropical sun on the foliage, the flowers, the fruit, the insects and the birds, stimulated the development of the colour sense, which appeared first among mammals in the capuchin monkeys ; and in these it is interesting that it appeared as a two-colour system as occurs in protanopic colour blindness in man. The environment of the tree-tops allowed our ancestors to throw away the shackles of the sense of smell, all-important for survival upon the earth beneath them. In this swaying habitat, springing from branch to branch, fine stereoscopic vision and perfect spatial judgments became necessary for survival ; to miss your foothold—or your hand-hold—meant, at the least, a broken limb ; so that in place of being merely used for running, the forelegs became prehensile hands accurately correlated in the cortex with vision ; thus was laid the foundation for the physical dexterity of man. The security of the tree-tops allowed an escape from the urgent fears of life on the ground with its teeming population of predators, so that the senses, not constantly alert for danger, turned to other things. Together the eyes and the hands explored new objects, giving rise to new associations within the brain, the birth of curiosity and inventiveness ; thus was laid the foundation for the intellectual supremacy of man (Fig. 15).

When the first tree-shrew left the ground in fear for the safety of the trees, it was indeed a poor thing ; but it had inadvertently chosen an ideal evolutionary forcing-house ; and when the ape-man descended from his

cradle in the trees with an eye-brain in place of a nose-brain, freeing his hands by becoming bipedal, safe in his new intelligence and cunning, he became the lord of the earth. He reached the critical point at which physical dexterity could combine with conceptual thought and the faculty of speech, and thus a new method of evolution became possible based on the transmission of cultural experience rather than on the transmission of physical qualities alone. He had become modern man.

It is important to realize that in the animal kingdom generally, the parvenu sense of vision is not particularly associated with affective tone as other more fundamental senses seem to be. Its function is to register, and its rôle passive. The peahen doubtless views with interest the colour display of the peacock's tail ; but the interest is probably an instinctive sex-association, and not a vivid aesthetic emotion. No dog gazes with rapture at the glories of a sunset or a rainbow in the same way as the cat revels in the warmth of a fire or purrs to the tactile luxury of stroking. To many lower mammals, scents may have an urgent meaning, sometimes of danger, perhaps sometimes of ecstasy ; but vision, no.

Apart from instinctive responses, the only species to show visual curiosity and appreciation, an interest in exploring the potentialities of

Fig. 15. The red-eared monkey (*Zool. Soc. London*).

vision in an experimental fashion, are the higher anthropoid apes. The chimpanzee, for example, will amuse himself by looking at the world in different ways—by looking upside-down, by bending down and looking through his legs, by punching a hole in a leaf and peering through it, or by making a pool of urine and regarding his reflection therein. This is the beginning of something new and big. It is the first indication that vision has become elevated from the level of biological usefulness to approach that of aestheticism. To the lower animals a visual perception seems to be merely the appreciation of something that repetitive experience has taught them to presage good or ill for their lives, their stomachs, or the perpetuation of their species. Now in the chimpanzee, and presumably in his cousin, the ape-man, we see the emergence of a new quality, of an active rather than a passive character, a quality by virtue of which we, his descendants, look at a sunset or a rainbow and call it beauty.

Here then is how I picture the emergence of vision in the animal world—stated in terms of Lloyd Morgan's theory of emergent evolution or Wundt's creative syntheses. As complexity in evolution increases, every now and then a stage is reached when something new and surprising emerges, something which could not have been foretold because it represents something greater than the summation of its constituent parts. When atoms come together they form a molecule with properties quite unlike the atoms. When the appropriate molecules combine in bewildering complexity, life is formed; at a later stage—or perhaps contemporaneously—consciousness emerges. In a philosophy such as this I see the development of vision in the animal world in three emergent stages.

We start with a Motor Taxis. This first appeared when life began in the simplest unicellular organisms, as a reaction initially automatic and rigid, not necessarily associated with consciousness. It eventually became more plastic when visual perceptions became available to react with it, and it reached its culmination in the homing capacities of birds.

The second emergent I would call Perceptual Vision. It deals with practical things in a pragmatic way, the eye a photographic camera dealing first in light alone, then in movement, then in form, and eventually in colour too, and the brain a receiving screen, but acting essentially as a passive register. It emerges when a brain-ganglion appears in worms, for it needs a central nervous organization to weave its symbolism on the receiving screen. At first it takes a minor and eventually a major part in the determination of conduct, concerning itself primarily with the biologically urgent instincts of hunger, fear, and sex; and its function is merely to observe and to report.

The third emergent I would call Imaginative Vision, endowed with artistic and creative qualities, charged with an inquisitive, exploratory drive. Its emergence waited on the almost explosive development of the fore-brain and the association areas in the highest primates. It first

21

appeared, presumably, during the ape-man's arboreal adventure, and certainly its early beginnings are seen in the chimpanzee, and it was well established when modern man migrated northwards from Africa following the melting of the ice, 20,000 years ago, to draw the pictures of the Aurignacian and Magdalenian civilizations in the caves of Southern France and Northern Spain ; it reaches its greatest development, perhaps, in the human mind relieved of the chemical servitude of inhibitions, as by mescalin, under the influence of which visual appreciation becomes charged with an exquisite poignancy.

Granted, then, that animals, including worms and above this level, see, the question arises, what do they see ? Granted that they see the same world around them that we do, full of the same things with the same kaleidoscopic variations in relationships, what do they make of it all ? We do not know. The territory-holding male robin pays no attention to an exact stuffed replica of itself so long as the breast is brown ; but will attack viciously a formless untidy mass of feathers, so long as they are red. Even in man, an analysis of perception is impossible. The brain of each of us creates a symbolic representation of the outside world, but this personally created world of symbols is our own and private. How sure are we that we all see the same blues, and yellows, and reds ; and have we tried to visualize the world as it appears to the colour-blind? To some a painting by Picasso is more full of meaning than is the *Mona Lisa*, just as to some the glory of an opera of Wagner is but a noise.

And if in our wordy thinking we find difficulty in submitting our own perceptions to scientific analysis, how much more insecure are when we try to analyse the experiences of the dumb creature ? As we reason by analogy and experiment within the different groups of animals, we are sure of one thing with certainty—that each species has its own perceptual world, and that each of this multitude of worlds bears little or no resemblance to the environment of the animal as we interpret it in terms of our own private perceptual world.

It must be remembered that a perceptual pattern arises from many different sensory impressions which present no additive qualities among themselves, some derived from the outside world, others from the individual himself. The impulses from the outside world are integrated in the central nervous system, be it a simple ganglion or a ten-thousand-million-celled brain. This is brought about by the facilitation of the accustomed and the inhibition of antagonistic impressions, a process in which a thousand are inhibited to allow the passage of one, for only by the exclusion of the irrelevant can the important hold the stage. These are interwoven on a basis of inherited dispositions and past experience to form a perception. The conditioning influence of experience is continuously changing and essentially plastic in its nature. The inherited dispositions vary profoundly between species and even between individuals within a species. The final product is thus individualistic and capricious ; it lies

outside the physical laws by which we are accustomed to formulate the conduct of material events ; it carries with it the suggestion of a new creation rather than an ordered sequence of cause and effect, a computed product of in-put and out-put ; and, to complicate it all, like a melody it is four-dimensional, for it exists in time as well as space.

This, of course, is not to say that there need be anything supernatural about the process ; it is merely to say that it cannot be explained by the physico-chemistry that we have at our disposal, nor is it susceptible to such mathematical formulation as we know today or are likely to know tomorrow. Indeed, so far are we from understanding that if we argue that our own perceptual symbolism is the only real thing and the outer world is non-existent, none can gainsay us.

And, if I may surmise, I think it unlikely, as Parsons (1927) put it, that such a tomorrow will ever come within the experience of any of us for lack of adequate measuring-rods. Even if we analyse our own perceptions, knowledge of physical things can only be made available to us through our senses. A table cannot know of a chair ; we must ascend higher to the level of physiology and look down to measure and weigh them with our eyes and our fingers. Sensations can only be appreciated and interpreted by our perceptions. Vision knows nothing of hearing ; we must ascend higher to the level of psychology and again look down for such analysis. Similarly to explore perceptions we must perforce climb another stairway and again look down at the level beneath. Such a stairway may indeed exist, but with our limited mental endowments we cannot see it, far less climb it. In the storey above there may exist a God who can look down, or there may be nothing—or even a psychiatrist. But that is not science ; it is belief—or agnosticism—or self-deception.

It may be that some day we shall be able to climb to such heights. We have seen what the brain of a bee can do within the limits of 1/10 inch in diameter ; who can say that the brain of man with its 1,400 cubic centimetres has reached the limits of its potential complexity? That the neuro-surgeon can remove large parts of it without apparent disadvantage would seem to indicate that it has not. During the last 10,000,000 years of our arboreal and post-arboreal life, the brain of the ape-man has expanded three-fold in volume. Who can say that its progress is now frozen? Who knows what hydrocephalic-like monstrosities our descendants of 10 million years hence will be ? The step between ape and angel may not be so big as we think. New capacities and understandings may emerge ; but that is not today ; we cannot yet look beyond vision to the Void, and through the Void at objective reality ; and, of course, in assessing the potentialities of human progress in the next 10 million years, or indeed of human survival, we must remember the snag that the apes threw sticks and stones while we throw atom bombs.

23

REFERENCES

BOYCOTT, B. B., and YOUNG, J. Z. (1950) *Symp. Soc. exp. Biol.* **4**, 432.
——————————————— (1955) *Proc. roy. Soc. B.* **143**, 449.
——————————————— (1956) *Proc. Zool. Soc., Lond.* **126**, 491.
BRUN, R. (1914) *Die Raumorientierung der Ameisen.* Jena.
VON FRISCH, K. (1948) *Naturwissenschaften* **35**, 12, 38.
——————————— (1949) *Experientia* **5**, 142.
——————————— (1951) *Naturwissenschaften* **38**, 105.
——————————— and LINDAUER, M. (1954) *Naturwissenschaften* **41**, 245.
MATTHEWS, G. V. T. (1951) *J. exp. Biol.* **28**, 508.
——————————— (1953) *J. exp. Biol.* **30**, 243, 268, 370.
——————————— (1955) *J. exp. Biol.* **32**, 39.
——————————— (1955) *Bird navigation.* Cambridge.
PARSONS, J. H. (1927) *Introduction to the theory of perception.* Cambridge.
SANTSCHI, S. (1911) *Rev. suisse Zool.* **19**, 117.
WALTER, W. G. (1953) *The living brain.* London.

APPOINTMENT OF FELLOWS AND MEMBERS TO CONSULTANT POSTS

G. R. CARR, Ch.M., M.D., F.R.C.S.	Consultant Surgeon to Stockport and Buxton Group of Hospitals.
D. L. CHADWICK, M.D., F.R.C.S., D.L.O.	Consultant E.N.T. Surgeon to Crumpsall, Ancoats and Manchester Ear Hospitals.
A. STANDEVEN, M.A., M.Chir., F.R.C.S., F.R.C.S.Ed.	Consultant General Surgeon to S.E. Kent Group of Hospitals.
P. BOREHAM, M.Chir., F.R.C.S.	Consultant Surgeon to Cheltenham General Hospital.
J. I. WAND-TETLEY, M.B., M.R.C.S., M.R.C.P.	Physician in Physical Medicine to Edgware General & National Temperance Hospitals.
S. TISCHLER, M.R.C.S., L.R.C.P. D.P.M.	Psychiatrist to High Wick.
T. LING, M.R.C.S., M.R.C.P.	Psychiatrist to Marlborough Day Hospital.
K. C. ROBINSON, M.D., M.R.C.S., M.R.C.P.	Geriatrician to West Herts Group.
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D. PREISKEL, M.D., M.R.C.S., M.R.C.P.	Physician in Physical Medicine to Acton Hospital.
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M. I. WRAY, M.B., M.R.C.S., L.R.C.P., D.M.R.D.	Radiologist to Barnet General Hospital.
G. E. STEIN, M.B., F.R.C.S.	E.N.T. Surgeon to Acton Hospital.
J. G. ROBERTS, M.B., F.R.C.S.	Assistant Neurosurgeon to Central Middlesex Hospital.

The Editor is always glad to receive details of new appointments obtained by Fellows and Members, either through the Hospital Boards or direct.

RECENT OVERSEAS VISITORS TO THE COLLEGE

RECENT OVERSEAS VISITORS to the College have included Professor F. L.-P. de G. d'Allaines, Professor of Surgery in the University of Paris, who was admitted to the Honorary Fellowship on 11th June : and Mr. and Mrs. I. B. Jose of Adelaide who attended the Monthly Dinner in June.

THE MECHANISM OF CONGENITAL HYDRONEPHROSIS
WITH REFERENCE TO THE
FACTORS INFLUENCING SURGICAL TREATMENT

Hunterian Lecture delivered at the Royal College of Surgeons of England

on

30th January 1958

by

G. F. Murnaghan, F.R.C.S., F.R.C.S.E.
Lecturer, Institute of Urology, University of London

THE MODERN TENDENCY towards conservative surgery in the treatment of hydronephrosis has aroused new interest in the problem of defining the primary cause of the idiopathic or congenital type of this disease. Early exploration of the condition is now common practice and provides an opportunity for the study of the pelvi-ureteric region before stasis and infection have rendered the renal pelvis inert and before the cause and the effect of the pelvic dilatation are largely confused. Such opportunity prompted these investigations into the dynamics of the upper urinary tract in congenital hydronephrosis and allowed for the movement patterns which were observed to be correlated with the gross and microscopic appearances of the pelvi-ureteric junction.

The observations have been made upon thirty-five patients with hydronephrosis which could not be attributed to any definite cause such as calculus, tumour or lower urinary tract obstruction. A series of controls was obtained from seven patients who were subjected to nephrectomy for early renal disease, supplemented by specimens obtained from healthy pigs immediately after slaughter. The pig was chosen in support of the normal pattern because the musculature of its upper urinary tract is similar to that in man, and conducts the same average volume of urine each day.

The movements of the intact renal pelvis and upper ureter have been studied during cinepyelography or at operation, and many of the pelvi-ureteric segments which were excised either at nephrectomy or pyeloplasty were perfused in a physiological bath so that their contractions could be observed under controlled conditions. All the material has been examined histologically with particular reference to the arrangement of the muscle fibres at the pelvi-ureteric junction.

It has obviously not been possible to apply all the techniques to each of the cases and statistics will not feature in any of the argument. The purpose of the lecture is to animate the pathology of congenital hydronephrosis and to demonstrate in terms of abnormal contractions those various aetiological factors which have previously been described.

The physiology and anatomy of the renal pelvis and ureter

Though it is generally accepted that urine does not simply flow from the

25

kidney to the bladder but is actively propelled by the contractions of the renal pelvis and the ureter, it is often assumed that such a mechanism must require supervision by the autonomic nervous system. There is, however, no definite myenteric plexus in the wall of the ureter and Satani (1919) failed to demonstrate any ganglion cells in its muscle coat. In the human subject it was noted by Kiil (1957) that the contractions of the ureter are not directly affected by agents which might be expected to interfere with nervous control. The observations of Lapides (1948) support the contention that the contractions of the ureter arise as the response of the smooth muscle coat to the stretching of its fibres by the urine excreted from the kidney whilst the rate of urine excretion appears to be the sole controlling factor of the force and frequency of such contractions. It was the opinion of Engelmann (1869) and of Bozler (1938) that the contractile process is propagated from muscle cell to muscle cell without the intervention of a nervous mechanism.
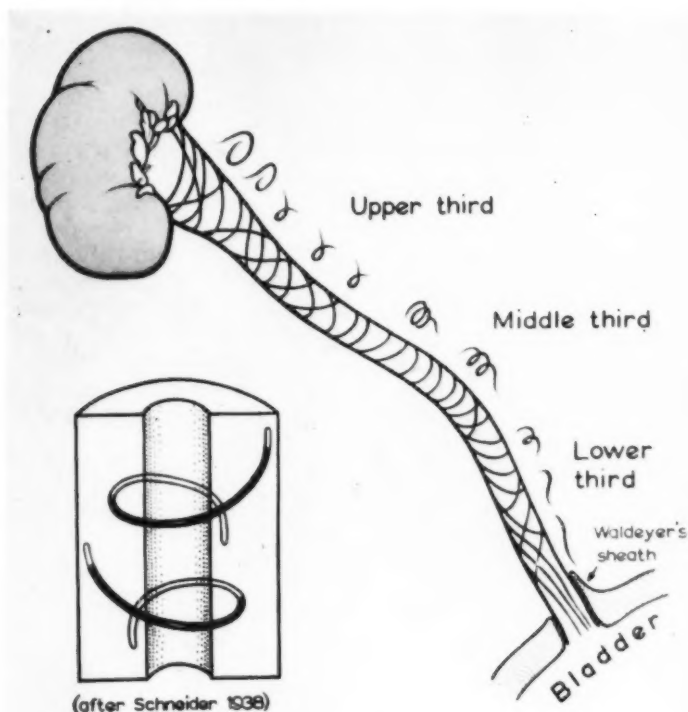
Fig. 1. Arrangement of muscle fibres in the ureter.

The layers of muscle in the renal pelvis and ureter are rather ill-defined and, according to Schneider (1938), the bundles of fibres form an inter-lacing series of spirals. These begin as longitudinal strands in the outer region of the musculature (Fig. 1) and form a middle circular layer as they describe their spiral turn before terminating as longitudinal fibres adjacent to the submucosa. In the renal pelvis they form a predominantly circular muscle coat which has a few coarse oblique fibres on its outer surface, but as the pelvi-ureteric junction is approached all the spirals become intermingled and the muscle bundles pass in all directions. Such mixed spirals are present throughout the upper third of the ureter and no definite junction between pelvis and ureter can be identified on histological examination. In the middle third the spirals are more tightly wound to form a thick coat of predominantly circular muscle but towards the lower end they are apparently open and elongated because the muscle bundles are chiefly longitudinal in disposition and true circular fibres are to be found only in a tongue of bladder muscle which is closely applied to the lower end of the ureter in the form of Waldeyer's sheath.

The renal pelvis and ureter may therefore be considered as a single propulsive unit, composed of an interlacing series of smooth muscle fibres whose activity is largely independent of autonomic nervous control.

The contractions of the normal renal pelvis and upper ureter

The use of the X-ray image intensifier during cinepyelography, as described by Hanley (1955), facilitates the study of the movements of the upper urinary tract in man under comparatively normal conditions, but it is still usually necessary to introduce the radio-opaque media through ureteric catheters in order to obtain sufficient contrast and there may therefore be an element of artefact unless filling of the pelvis is extremely gentle and the catheter is removed some time before any significant observations are made. In the horizontal position the contractions of the calyces do not appear to have any regular sequence and though they usually pass into the wall of the renal pelvis there is no definite synchro-nization of the activity of these compartments. The pelvis may contract independently of the calyces possibly as its own response to distension by the urine ejected into it, and some of the calyces may be actually distended by the pelvic contractions as if taken unawares and with their mouths wide open.

In sharp contrast with these variations it has repeatedly been observed that all the contractions of the pelvis, however they may arise, are propagated across the pelvi-ureteric junction without any hesitation and proceed onwards along the ureter.

There is therefore co-ordination of the contractions of the normal renal pelvis and upper ureter in the intact human subject and it is associated with the uniform arrangement of mixed muscle spirals at the pelvi-ureteric junction and with the notable absence of any sphincter at this

27

site. This co-ordination may also be observed at operation and such normal pelvi-ureteric segments have been available for perfusion experiments after nephrectomy for early renal disease.

The method of perfusion

In view of the apparent indifference of the upper urinary tract to any direct influence of the autonomic nervous system, the movements of isolated segments are probably of functional significance provided that the conditions during perfusion are adequately controlled and no recording devices anchor the ureter or lie within its lumen. Accordingly the excised specimens were immersed in an oxygenated bath of tyrode Ringer solution at body temperature and they were perfused with this same fluid from a tap funnel which controlled the rate of flow. When the preparation was assembled as shown in Figure 2 and perfused at a constant rate, the pressure within its lumen depended largely upon the resistance to flow which could be varied by changing the pressure in a stout glass chamber surrounding a soft rubber tube, through which the ureter was made to empty. Static pressures were read from the simple tube manometers at the inlet and the outlet, but these manometers were occluded when the contractions of the specimen were being observed, so that the volume changes were more accurately controlled. For the purpose of recording typical contractions, a simple optical system was incorporated into either manometer. This instrument was devised by Mr. David Wallace at the Institute of Urology and utilizes the principle that the glass manometer tube is converted into a lens system by the fluid which it contains and thereby focuses the slit lamp on to the recording paper, whilst the empty tube above the meniscus simply diffuses the light.
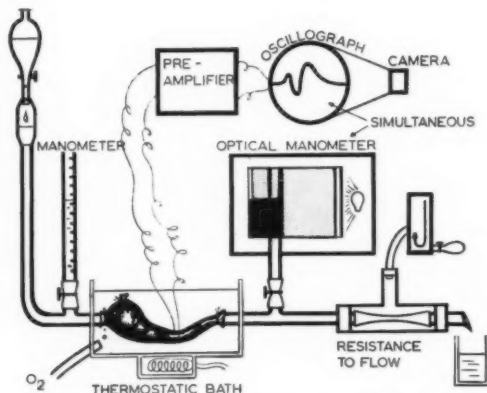
(Reproduced by kind permission of the British Journal of Urology.

Fig. 2. Method of recording the activity of the isolated perfused ureter.

The electrical responses of the isolated ureter have also been traced on an oscillograph during perfusion but they have been recorded by polarisable electrodes and their value is empirical. They probably represent movement potentials rather than muscle potentials and consequently were not recorded on many occasions in this series lest the needles themselves interfered with the contractions of the preparation.

The pathological method

Any unusual site of origin or fade of the contraction process which was observed during perfusion was marked on the specimen, and after removal from the bath the segment was slit lengthwise, smoothed out and pinned on to a cork sheet to avoid distortion during subsequent fixation. Alternatively, the specimen was fixed by gentle distension with formol saline and was thus available for serial longitudinal or transverse section. It has not been practicable to examine many long segments of ureter by serial section and the technique of cutting longitudinal strips which has been used formed a quick and satisfactory method of sampling the muscle coat at various levels. After fixation each specimen, whether incised or distended, was photographed against a scale so that the positions of any strips of tissue which were selected for histological examination could be marked on the photograph. By this method it was possible to be accurate in the correlation of the histological appearances with the gross specimen and with the movement patterns previously recorded.

During the perfusion of segments of excised ureter it has been noted that the contractions tend to begin where the circular muscle is subsequently found to predominate and in the normal tract such muscle is located either in the pelvis or in the middle ureteric spindle. The pelvis is the first portion of the tract to be distended and even when detached from its calyces it has a more frequent rhythm of contraction than the middle spindle and therefore acts as the pacemaker during the perfusion of whole lengths. From the observations made during the perfusion of many segments of human and pig ureter it could be suggested that the movements of the isolated ureter are the result of two fundamental types of contraction which depend upon the pressure of perfusion. At low pressures and in any healthy segment the contraction travels in the form of a wave which presumably depends upon the local propagation of the excitation process along the muscle coat. Such waves can be seen at operation when the ureter is manipulated and may proceed in opposite directions from the point of stimulation. They are often referred to as " ureteral peristalsis " because they resemble the propulsive contractions of the small bowel but in the absence of a myenteric plexus in the ureter perhaps they should be referred to as " conducted contractions."

At higher perfusion pressures, though the ureter will still transmit wave contractions, it divides into a series of spindles, which are usually three in number and correspond roughly to the different patterns of muscular arrangement already described in the separate thirds of the ureter.

29

Under conditions of distension the pressure throughout any one spindle will be uniform so that all the muscle fibres in the wall of such a spindle would be subjected to stretch and could respond by a synchronous contraction which would involve the whole spindle simultaneously. The form taken by such a " distension response " as opposed to the wave of the " conducted contraction " will largely depend upon the disposition of the muscle fibres in its wall. Where circular fibres predominate there will be a " shut down " of the spindle with narrowing of the lumen but where longitudinal fibres are in high proportion the spindle shortens without undue diminution of its calibre. It might be anticipated at this stage that the degree of stretch allowed in any portion of ureter would be limited by fibrosis in its wall or by the proximity of medium-sized blood vessels whilst both the strength and propagation of any type of contractile process could be adversely affected by fatigue or disease of the muscle itself.

When the normal pelvi-ureteric segment is perfused, spontaneous contractions usually begin in the pelvis at a pressure of 2 to 5 cm. H_2O and pass across the junction without any hesitation to proceed onwards along the upper ureter. This pattern of behaviour is not altered by raising the distension pressure so that there always appears to be co-ordination of the contractions of the pelvis and upper ureter during perfusion and a series of such contractions are shown in Figure 3 as recorded on the outlet manometer.

outlet manometer tracing
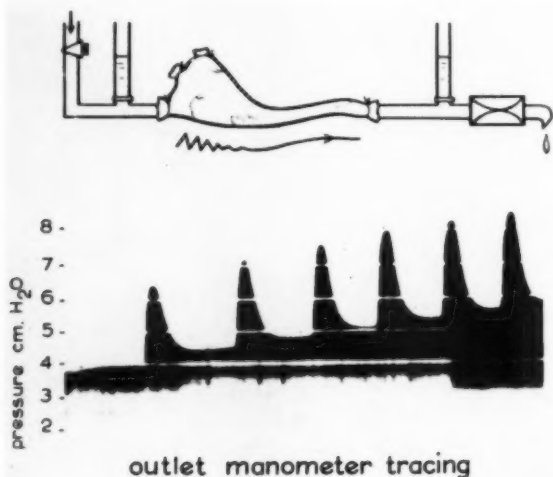
Fig. 3. The outlet manometer tracing obtained during the perfusion of a normal pelvi-ureteric segment.

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The pyelographic appearance of a typical funnel-shaped junction are shown in Figure 4 and the gradual change from the pelvis to the more narrow ureter can be clearly seen in the photograph of this specimen
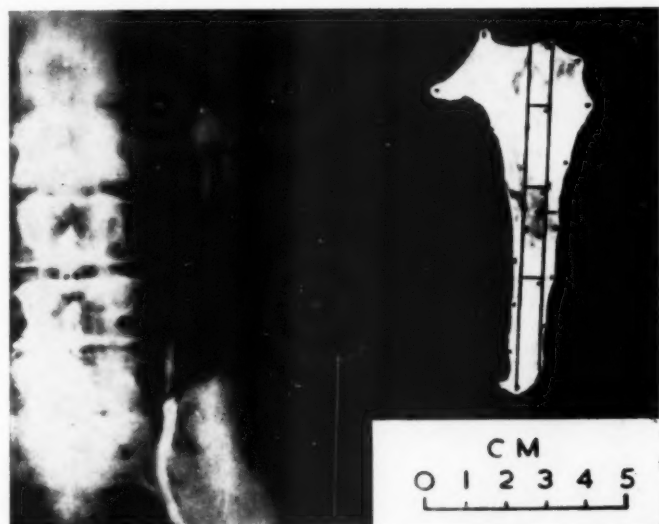
Fig. 4.   Retrograde pyelogram of a normal funnel-shaped pelvi-ureteric segment, and photograph of the pinned-out specimen with the site of histological sections marked.

after it had been incised lengthwise and pinned out prior to the selection of the marked strips for histological examination.   It is obvious that no particular portion of this specimen represents a definite junction and the histological appearances were found to be uniform throughout the middle section.   A typical section from the point marked by the arrow is shown on the photomicrograph (Fig. 5), from which it can be seen that the muscle bundles pass in all directions and are chiefly oblique, though the tendency for the more longitudinal fibres to be disposed in the inner and outer zones of the muscle coat supports the contention that the muscle bundles are arranged in mixed spirals.

The uniformity of this mixture of spirals throughout the lower pelvis, junction and upper ureter possibly offers a structural explanation for the co-ordinated movement of the pelvi-ureteric segment whilst its immediate continuity with the circular muscle of the pelvis proper, which is perhaps more sensitive to stretch, may obviate the necessity for this segment to initiate its own distension response at higher pressures.

31
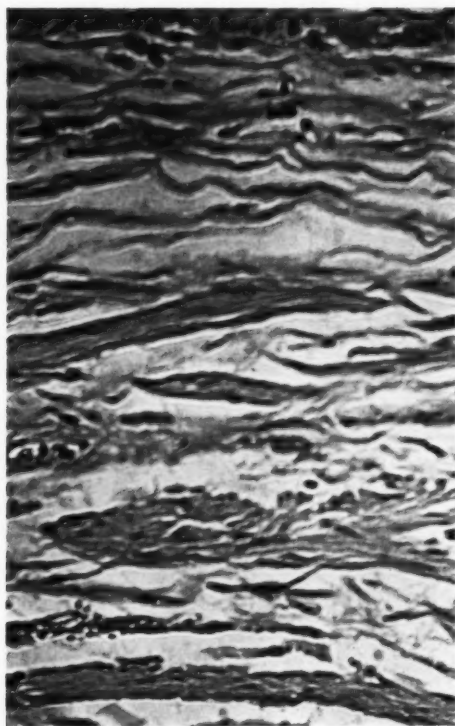
Fig. 5.   Photomicrograph of a longitudinal section through a normal pelvi-ureteric segment ($\times$ 400).

The close similarity of the movements of the upper urinary tract when observed during cinepyelography or at operation with those seen during perfusion of the isolated preparations supports the contention that the contraction process is both myogenic and autonomous.

The contractions of the upper urinary tract in congenital hydronephrosis

In some cases of congenital hydronephrosis it has been noted during cinepyelography that the normal propulsive movement of the pelvi-ureteric segment is replaced by a retraction of the junction and the contraction process hesitates at this well-defined point before proceeding along the upper ureter.   At operation it may again be found that the contractions begin in the pelvis and are propagated across the junction to proceed along the upper ureter in a co-ordinated and normal manner when the pelvis is not tense.   However, if the intrapelvic pressure is

THE MECHANISM OF CONGENITAL HYDRONEPHROSIS

gently raised by the direct injection of saline into the pelvic lumen it has been observed that the pelvic contractions fade at the pelvi-ureteric junction and the upper ureter contracts quite independently and at a slower rate.

Such abnormal pelvi-ureteric segments have been available for perfusion and at pressures of 3 to 4 cm. H_2O they have been found to behave in quite a normal manner and the junction has not appeared to interfere with the contraction process. When the perfusion pressure has been raised to 8 to 10 cm. H_2O the pelvic contractions have again been found to fade at the junction whilst the ureter contracts independently and at a slower rate. There is therefore an inco-ordination between the pelvis and upper ureter in these cases which can be induced by raising the intrapelvic pressure to a higher physiological level.

Figure 6 shows the outlet manometer tracing and electro-ureterograph as recorded during the perfusion of a renal pelvis and upper ureter which were obtained after nephrectomy for congenital hydronephrosis. It can be seen that though several pelvic contractions have occurred, there has been only one contraction of the upper ureter and because the contractions of the pelvis were recorded on the outlet manometer it can be assumed that the pelvi-ureteric junction remained patent throughout this activity and allowed the upper ureter to become distended and to respond with an occasional contraction.
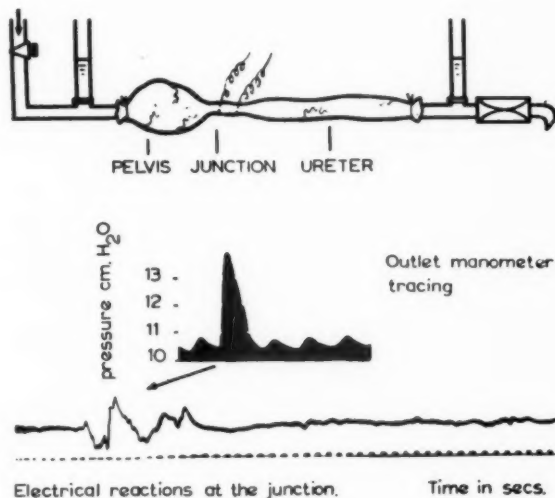
Fig. 6. Congenital hydronephrosis. Simultaneous outlet manometer tracing and electro-ureterograph demonstrating pelvi-ureteric inco-ordination during perfusion.

33

The small amplitude of the pelvic contractions may in part be due to pelvic fatigue, but nevertheless it seems obvious that the propulsive efficiency of the whole segment would have been greatly increased if each of these small contractions had been followed by a ureteric contraction of the same amplitude as the solitary one recorded on the tracing. The simultaneous electro-ureterograph from the junction shows the absence of the " normal " triphasic responses though it does record the isolated contraction of the ureter beyond.

Subsequent measurement of this specimen showed that though the pelvi-ureteric junction appeared to be stenosed it had in fact a mucosal circumference of 9 mm., which allowed it a possible diameter of 3 mm. On histological examination it was found that in the region of the pelvi-ureteric junction there was an unusual predominance of longitudinal muscle which extended through the relatively narrow portion of the segment for several millimetres. Apart from some adventitial fibrosis and hypertrophy in the pelvis, the remainder of the specimen showed no abnormality and its muscular arrangement conformed to the normal pattern.
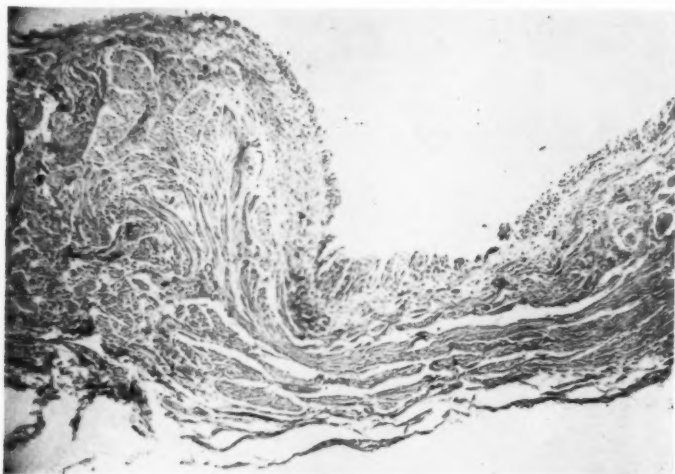
Fig. 7. Congenital hydronephrosis. Photomicrograph of a longitudinal section through the pelvi-ureteric junction ; the muscle is predominantly longitudinal in disposition and is reduced in bulk (× 66).

It thus appears that in congenital hydronephrosis there may be a basic mechanism of inco-ordination between the contractions of the pelvis and upper ureter which is possibly due to a failure of the changeover from a low pressure conducted contraction to a high pressure distension

response at the pelvi-ureteric junction. In many cases this mechanism has been found to be associated with an undue predominance of longitudinal muscle fibres at the junction where there may also be a reduction in the total muscle mass (Fig. 7).

It is interesting to note that this mechanism could be induced during the perfusion of a normal pelvi-ureteric segment by gently crushing the approximate site of the junction with a forceps and thereby interfering with the conduction of the contraction process. When the lumen had been restored by separating the crushed mucosal surfaces with a fine bougie, it was found that the ratio of the contraction rates of the pelvic and ureteric components of the segment had changed from 1 : 1 to 8 : 1 whilst the volume output of the segment was reduced by about 50 per cent. The inefficiency of the inco-ordinated pelvi-ureteric segment as a propulsive unit appears to be inherent in the inco-ordination and not necessarily dependent upon any reduction in the lumen at the junction.

Stenosis in congenital hydronephrosis

In hydronephrosis a medium-sized ureteric catheter will often pass into the renal pelvis without difficulty even though the appearances of still and cinepyelograms suggest that some degree of stenosis is present at the pelvi-ureteric junction. Such direct calibration of a contractile tube may be of doubtful significance but it does at least indicate that, in the majority of cases, the cause of the hydronephrosis is probably to be found in the dynamics of the pelvi-ureteric segment rather than in its lumen.

During the perfusion of such excised segments, the junction never restricted the passive flow of fluid and the inlet and outlet manometers always equalized promptly during the intervals between contractions. There were two cases in which marked stenosis at the junction was considered to be the cause of the hydronephrosis when the region was exposed at operation, and these segments were available for perfusion after Anderson Hynes pyeloplasty. Fluid flowed easily through them both but, as the distension pressure rose and they became active, it was observed that such flow was interrupted quite suddenly at the precise moment of contraction. Figure 8 shows the manometer tracings produced by such a contraction during perfusion with the outlet occluded. The outlet manometer traced the gradual rise in distension pressure whilst the segment was quiescent, but it failed to record the contraction which registered so clearly on the inlet manometer and it is apparent that such contractions produced a complete closure of the junction. On histological examination it was found that each of these two segments had the normal arrangement of mixed muscle bundles in the wall of the stenosed junction so that it is possible that the contraction of the circular element in their spiral musculature was responsible for the intermittent obliteration of the narrow lumen.

35

MANOMETER TRACINGS
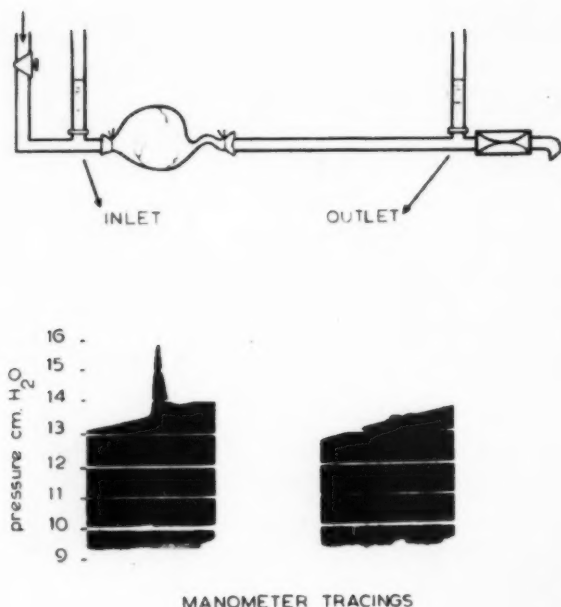
Fig. 8. Manometer tracings from the renal pelvis and upper ureter demonstrating closure of the narrow pelvi-ureteric junction by the contractions of the segment during perfusion.

Such active constriction was not observed during the perfusion of any of the remaining cases but definite inco-ordination of the contractions of the pelvis and ureter was demonstrated by gently raising the perfusion pressure. This inco-ordination was also noted at operation in cases which were then contractile though their excised segments were either too small to be perfused or were subsequently inert in the bath. The actual size of the lumen was therefore of serious dynamic significance in only two cases whilst in the remainder the lumen remained patent at all pressures. In this larger group of cases it was reasonable to attribute the hydronephrosis to the inefficient, inco-ordinate contractions of the pelvi-ureteric segment and on histological examination the majority of these cases were found to have a predominance of longitudinal muscle at the pelvi-ureteric junction whilst the remaining few showed severe local inflammatory change. Longitudinal muscle would allow the ureter at the junction to elongate rather than to dilate under conditions of relaxation or distension. Such elongation at the junction might produce the contrast with the

dilated pelvis above or the normal ureter below which could possibly explain those appearances of relative stenosis at the junction which are commonly encountered at operation or visualized during pyelography.

Inflammation in congenital hydronephrosis

The presence of old inflammatory change in the pelves and ureters of early specimens of hydronephrosis as noted by Winsbury White (1925) strongly suggests that such inflammation may have actually preceded or indeed may have caused the pelvic dilatation. Jewett (1940), however, maintained that inflammatory fibrosis was not likely to produce stricture formation at the pelvi-ureteric junction unless it was superimposed upon some degree of congenital stenosis. Perhaps too much emphasis has been placed upon the actual size of the lumen and insufficient attention given to the effects that such inflammatory change might have upon the contractility of the tissues. Moreover, the pelvi-ureteric region in early hydronephrosis may be quite normal in appearance when exposed at operation and it is then surprising to find that inco-ordination of the pelvis and upper ureter may be induced by gently raising the intrapelvic pressure by direct injection. The junction from such a case was resected and subsequent histological examination showed that though its muscle coat was normal in arrangement there was an obvious local increase of fibrous tissue in the submucosa. It is therefore suggested that this fibrosis limited the stretch response of the muscle at the junction and induced the hydronephrosis through the mechanism of inco-ordinate contractions rather than by simple encroachment upon the lumen.

Eventually the residuum of urine leads to recurrent infection in practically all cases of hydronephrosis and produces hypotonia of the muscle with a gradual increase in the dilatation so that the pelvis becomes decompensated and inert. Such advanced cases usually require treatment by nephrectomy and it has therefore been possible to perfuse the pelvis with a long length of upper ureter on these occasions. It has then been apparent that when the inert pelvis fails to provide the upper spindle of ureter with its usual conducted stimulus, an abnormal stimulus is derived from the middle ureteric spindle below. The middle spindle has a faster rhythm of contraction than the upper spindle because its circular muscle coat is perhaps more susceptible to stretch and is anyway more distant from the inflammatory process. When the contractions begin in the middle spindle they cause a rise in pressure both in the pelvis and in the ureter as recorded on the inlet and outlet manometers (Fig. 9). As this contraction is conducted in a retrograde manner along the upper spindle, the rise in pelvic pressure is maintained but there is a simultaneous fall in the ureteric outlet pressure so that this contraction is apparently accompanied by a reversal of flow in the upper ureter. If reflux into the pelvis is restricted in any way, then such reversal of flow may simply lead to a dilatation of the upper ureter.

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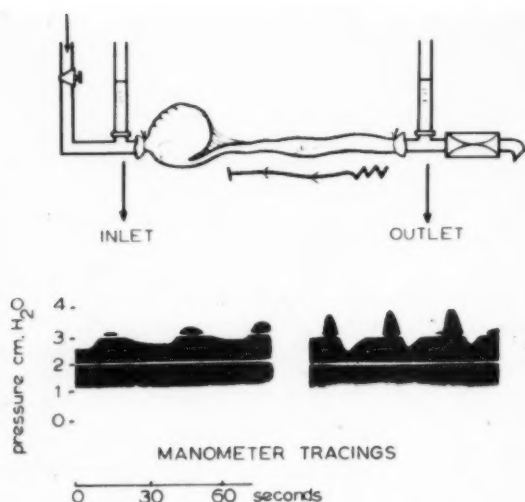
Fig. 9. Manometer tracings from the renal pelvis and upper ureter demonstrating the reversal of flow produced by retrograde contractions of the upper ureteric spindle during perfusion.

The origin of these retrograde contractions does not appear to depend upon any degree of mechanical obstruction at the junction because they were observed during the perfusion of a renal pelvis and upper ureter which were obtained at nephrectomy for the relief of a renal calculus with infection.

The removal of the calculus prior to perfusion gave the specimen a new lease of life and at a distension pressure of 7 cm. H_2O it contracted spontaneously and with the normal sequence from pelvis down to middle spindle. After perfusion for 20 minutes the pelvis gradually became inert and when it ceased to contract it was observed that the middle spindle became the pacemaker so that retrograde contractions passed along the upper ureter. They would not, however, pass the pelvi-ureteric junction and did not stimulate the pelvis which was the site of marked inflammatory change even in its muscle coat.

Though it is important to stress that such retrograde contractions have not been observed during cinepyelography or at operation, they have always been present during perfusion when the pelvis was inert and when the active segment of ureter included a portion of the middle spindle which could be identified on histological examination by the circular arrangement of its musculature. It could therefore be suggested that in the later stages of hydronephrosis, the failure of the pelvis to empty

may be aggravated by a reversal of both contractions and flow in the upper ureter.

High uretero-pelvic insertion

When hydronephrosis becomes advanced there is a downward sagging of the dilated pelvis which places its outlet into the ureter in a relatively high position and produces a valvular obstruction to emptying which bears no direct relationship to the primary pathology at the junction itself (Fig. 10). This mechanical obstruction can best be demonstrated
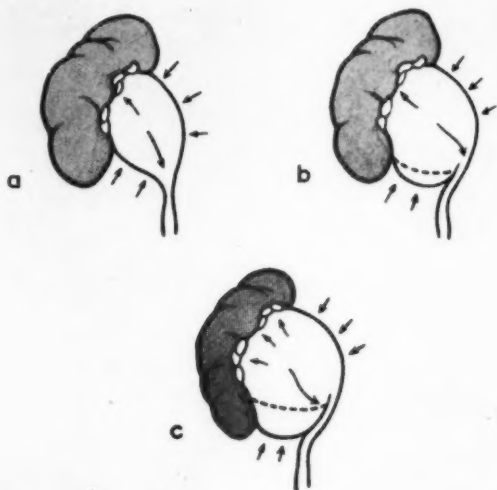
Fig. 10. Diagrammatic representation of high uretero-pelvic insertion with mechanical obstruction to pelvic emptying.
(a) Mild ; (b) moderate ; (c) advanced hydronephrosis.

during the perfusion of an inert specimen when it is found that the pelvis can be filled from the ureter though the ureter will not fill from the pelvis despite rapid perfusion even at high pressure.

Such development of high uretero-pelvic insertion probably represents the critical stage in the pathology of any particular case. If a paradox can be expressed in a colloquialism this stage is the " point of no return " for the pelvic dilatation though it may be the stage at which retrograde filling from the upper ureter is most likely to occur. Despite some recovery of pelvic tonus or renal secretion, the rise in intrapelvic pressure which is produced by such improvement will lead only to a more secure occlusion of the pelvic outlet. The high uretero-pelvic insertion is frequently secured

39

as a permanent deformity by fibrous adhesions between the upper ureter and the renal pelvis. These adhesions are generally considered to be of inflammatory origin but Ostling (1942) noted that they were present as soft fibrous folds in some early cases of hydronephrosis, and after a careful study of their microscopic structure he concluded that they were due to persistence of those physiological folds of adventitia which are present around the upper ureter in the developing foetus. In early hydronephrosis they present either as a sail-shaped adhesion or as an adventitial curtain (Fig. 11) and are in continuity with the pelvic adventitia. They co·
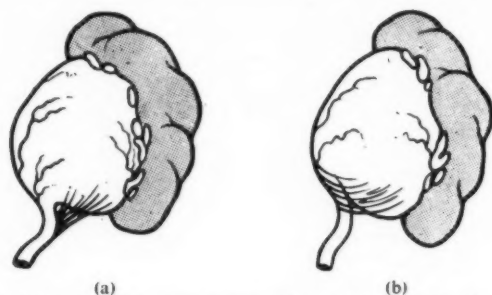
Fig. 11. Pelvi-ureteric adhesions in congenital hydronephrosis. (a) Sail-shaped adhesion ; (b) adventitial curtain.

therefore be expected to tighten when the pelvis contracts and to draw up the ureter with angulation or else bind it to the pelvis with occlusion of the outlet. At operation or during perfusion such folds do not apparently interfere in this way and though some retraction of the junction does occur it appears to be the result of an intrinsic inequality in the muscular contraction of the junction itself. This may be related to a predominance of longitudinal muscle such as was found on histological examination of the renal aspect of the junction in the specimen shown in Figure 12.

Lower polar renal vessels in hydronephrosis

Before it was fully appreciated that lower polar renal vessels did not provide an accessory blood supply to the kidney, they had rather an evil reputation which was almost implied by their description as " aberrant." Eisendrath and Rolnick (1942) noted that such vessels cross 6 per cent. of normal pelvi-ureteric junctions and this high incidence suggests that they are merely aggravating factors when present in hydronephrosis. It was almost with relief, therefore, that the mechanism of hydronephrosis as already described, with its associated muscular derangement, was found in three of the fifteen cases of this series in which anterior lower polar vessels were present. The remaining twelve cases shared some features which formed them into a rather select group. They generally presented with a short clinical history and on investigation the affected kidney
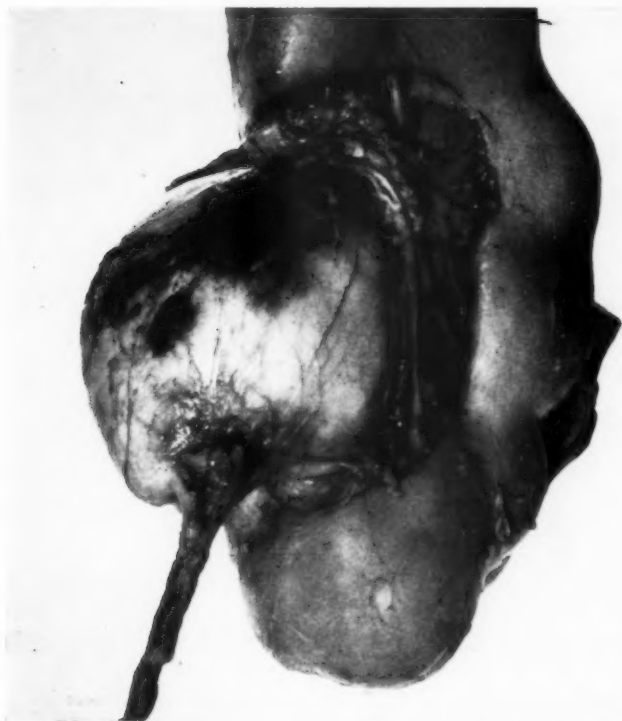
Fig. 12.   Nephrectomy specimen of congenital hydronephrosis with sail-shaped
pelvi-ureteric adhesion.

showed very poor or absent concentration on intravenous pyelography.
There was however no higher incidence of these cases in any particular
age group so that it is suggested that the lower polar vessels were associated
with a more rapid development of the hydronephrosis but only during
its later stages.   Despite early exploration, the pelvic dilatation was
frequently very advanced and, at operation or perfusion, the renal pelvis
was often inert especially after distension.   Moreover, it was repeatedly
found that the area of contraction fade coincided exactly with the site
at which these vessels crossed the ureter, regardless of whether this point
happened to be the junction itself.   It was also noted that even the low
pressure conducted type of contraction refused to pass across such
localities but no characteristic histological findings were discovered to
explain this failure in contractility.   The musculature in the renal pelvis
showed a varying degree of hypertrophy which usually ended abruptly at

41

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the macroscopic pelvi-ureteric junction and only occasionally did it extend down the upper ureter to the actual site of vascular crossing. In all these twelve cases the muscle bundles were arranged in a basically normal mixed pattern, and it can therefore be assumed that in many cases of hydronephrosis lower polar vessels interfere with contractility at the pelvi-ureteric junction and that during the later stages of the pelvic dilatation they assume a position below the junction but continue to interfere even with conducted contractions. It was in this group of advanced cases that the high uretero-pelvic insertion was so obvious and it was during their perfusion that the retrograde contractions of the upper ureter were most frequently observed. There are therefore reasonable grounds to suspect that such vessels might cause many cases of hydronephrosis and there is also little doubt that they can aggravate the condition during its later stages. The kidney is anchored by its pedicle and surrounded by strong fascia so that any dilatation of its pelvis is accommodated by medial extension until it impinges upon the psoas
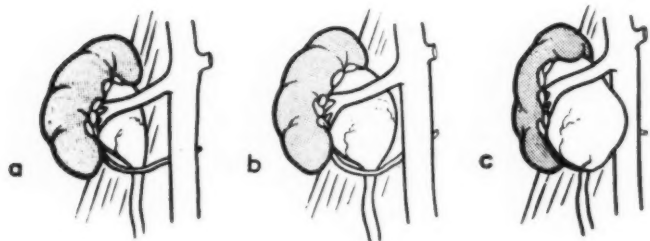
Fig. 13. Diagrammatic representation of the relation of lower polar renal vessels to the pelvi-ureteric junction. (a) Normal ; (b) early hydronephrosis ; (c) advanced hydronephrosis.

muscle (Fig. 13). Further enlargement would require the renal pelvis to move forwards and the kidney would be rotated about its long axis so that any anterior lower polar vessels would be brought into closer apposition with the junction and aggravate the hydronephrosis, whatever its cause. At this stage the dilating pelvis would tend to place its outlet in a relatively high position, and might even herniate forwards between the two vascular bundles to produce a serious mechanical obstruction to the urine flow, despite the fact that the junction may be quite wide and its muscular structure quite normal.

Non-mechanical hydronephrosis

Sometimes at operation for the relief of hydronephrosis it is found that there is no evidence of stenosis, adhesions or lower polar vessels at the pelvi-ureteric junction. It has been suggested by Underwood (1937) that the pelvic dilatation in such cases is due to " neuromuscular inco-

ordination " which may lead to atony of the pelvis or to achalasia of the junction. It is interesting to note that in such cases it has been possible to demonstrate a predominance of longitudinal muscle at the junction and to detect an inco-ordination of the contractions of the pelvis and ureter at operation. Moreover, the predominance of long muscle may be confined to the renal aspect of the junction as shown in Figure 14, and there may also be an active kink formation to share the responsibility for the impairment of urine flow through the junction.

(a)   (b)
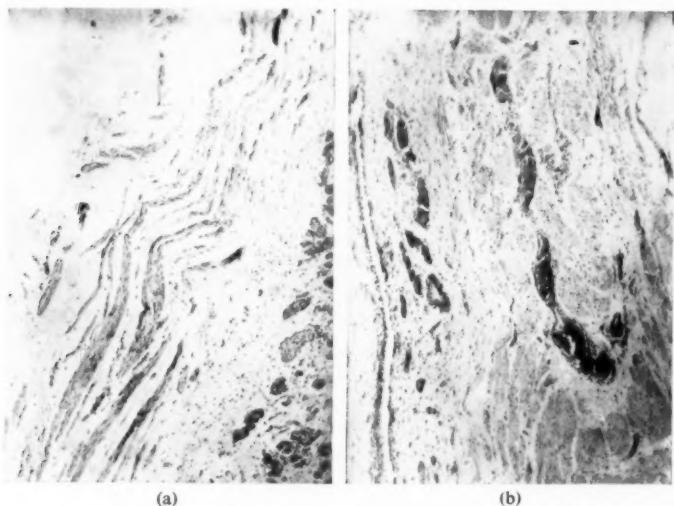
Fig. 14.   Photomicrograph of longitudinal sections through (a) the renal aspect ; and (b) the vertebral aspect of the pelvi-ureteric junction in " non-mechanical " congenital hydronephrosis (× 50).

Improvement in this " non-mechanical " type of hydronephrosis has been reported by Oldham (1950) following renal denervation, but such observations do not necessarily conflict with the thesis that both the normal and abnormal contractions are myogenic and autonomous.

In the experimental animal it has been shown by Dirner and Thuranskey (1954) that drugs and nervous stimuli alter the intrapelvic pressure by their effect upon the renal blood flow, and it is thus possible that denervation may alter the dynamics of the abnormal segment in this way rather than by any direct influence upon the muscle itself.   There is unfortunately no satisfactory method of recording the intrapelvic pressure in these patients without ureteric instrumentation and there has not, as yet, been an opportunity of examining the musculature of the junction in any case which responded favourably to denervation.

43

Significance of the mechanism in diagnosis and management

The frequent demonstration of a muscular derangement at the pelvi-ureteric junction does not necessarily imply that it constitutes the primary cause of hydronephrosis and careful study will be required before its pathological significance is fully appreciated. It is however of great interest to note that it was present in so many cases in which no other local factor could be found to explain the curious failure of the junction to transmit a contraction process after a relatively small rise in distension pressure. It could therefore be added to the list of those other lesions at the pelvi-ureteric junction which have been described as possible causes of hydronephrosis because it apparently shares with them all a mechanism of inco-ordination between the pelvis and the upper ureter. This mechanism is possibly the basic factor in the production of the pelvic dilatation which may be further aggravated by a reversal of flow in the upper ureter and by the later development of a valvular obstruction at the pelvic outlet.

In early hydronephrosis this inco-ordination may be the sole abnormality in the dynamics of the upper tract and its presence only at high pressure possibly explains the characteristic intermittent clinical history of such cases. The actual increase in pressure which is required to induce the inco-ordination appears to be rather small and it might well be produced by transient diuresis or recumbency. Consequently the intermittent early hydronephrosis may not be visualized by intravenous pyelography unless the examination is repeated during an episode of pain or with reproduction of the circumstances which induce an attack as advocated by Nesbit (1956).

The mechanism might also explain the development of hydronephrosis in the remaining kidney after nephrectomy because hydronephrosis is potentially bilateral and the added secretory load may raise the intrapelvic pressure to the critical level at which the inco-ordination is manifest.

The study of the contractions of any individual case at operation appears to be of fundamental importance and the technique of raising the intrapelvic pressure by direct injection has proved most useful. If the maximum amount of renal function is to be conserved, treatment must be early but it is in these early cases that at operation the pelvi-ureteric region is often normal in appearance and the continuous waves of contraction which pass the junction may discourage the operator from too much surgical interference. After gentle pelvic distension, however, it may be found that the contractions fade at the junction which becomes retracted as a knuckle and the upper ureter assumes its own slow rhythm of activity (Fig. 15). If lower polar vessels are present the movements of the pelvi-ureteric segment should be noted before they are disturbed, though this is a study which can be properly accomplished only through an anterior approach. It should be decided whether there is definite inco-ordination on pelvic

distension both before and after the vessels have been dissected free from the junction. In this way it should be possible to decide whether the vessels are the cause or a companion of the hydronephrosis and the most suitable procedure can then be carried out.

AT OPERATION PELVIS AND UPPER
URETER ARE NORMAL IN APPEARANCE
AND THEIR CONTRACTIONS ARE
CO-ORDINATED

BUT ON DISTENSION

— CONTRACTIONS FADE
AT THE JUNCTION

— KNUCKLE FORMS

— URETER INDEPENDENT
OF PELVIS
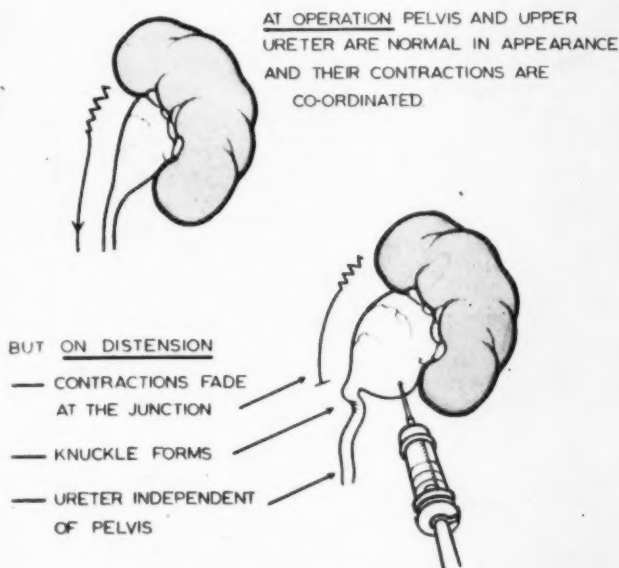
Fig. 15.   The demonstration of the abnormality of the pelvi-ureteric junction at operation in early congenital hydronephrosis.

In the later stages of hydronephrosis the detection of inco-ordination is perhaps not of such importance and more attention should be directed towards assessing the amount of renal tissue that remains. However, if conservation of the kidney is feasible the surgical procedure which is adopted should adequately prevent any future interference with the contraction process at the junction. It therefore seems reasonable in the treatment of congenital hydronephrosis—whether early or advanced—to advocate a resection of the pelvi-ureteric junction, with an adequate trimming of any redundant pelvis and the formation of a new pelvi-ureteric outlet at a dependent level and with an oblique anastomosis.

45

ACKNOWLEDGMENTS

REFERENCES

BOZLER, E. (1938) *Amer. J. Physiol.* **122**, 614.

DIRNER, Z. and Thuranskey, K. (1954) *Acta physiol. Acad. Sci. hung.*, **6**, 385.

EISENDRATH, D. H., and ROLNICK, H. C. (1942) *Urology*, 4th ed., p. 643. Philadelphia, Lippincott.

ENGELMANN, T. W. (1869) *Pflug. Arch. ges. Physiol.* **2**, 243.

HANLEY, H. G. (1955) *Brit. med. J.* **2**, 22.

JEWETT, H. J. (1940) *J. Urol.* **44**, 247.

KIIL, F. (1957) *The function of the ureter and pelvis*, p. 196. Philadelphia and London, Saunders.

LAPIDES, J. (1948) *J. Urol.* **59**, 501.

NESBIT, R. M. (1956). *J. Urol.* **75**, 767.

OLDHAM, J. B. (1950). *Ann. Roy. Coll. Surg. Eng.* **7**, 222.

OSTLING, K. (1942). *Acta chir. scand.* **86**, Suppl. 72.

SATANI, Y. (1919). *J. Urol.* **3**, 247.

SCHNEIDER, W. (1938) *Z. ges. Anat.* **109**, 187.

UNDERWOOD, W. E. (1937). *Proc. Roy. Soc. Med.* **30**, 817.

WINSBURY WHITE, H.P. (1925). *Brit. J. Surg.* **13**, 247.

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DURING THE LAST few weeks the following generous donations have been received :

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EARLY VISITORS TO THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND AND PHILIBERT JOSEPH ROUX'S ACCOUNT OF HIS OWN VISIT ON 21st AUGUST 1814

by
Claude H. Fleurent, L.-ès-L.
Chief Library Assistant, Royal College of Surgeons of England

THE REPORTS, FROM the Boards of Curators, of the Museum of the College, to the Court of Assistants of the Royal College of Surgeons in London (London, 1822) tell the story of the early years of the Hunterian museum from 1799, when the collection was delivered to the Company of Surgeons, to the year 1831. The museum was officially opened on 28th July, 1813, after the first building on the present site of the College had been completed. " The Prince Regent," William Clift wrote in his diary for that day, " visited the museum attended by Col. Bloomfield and Sir Thomas Tyrwhitt. The Master and Governors viz. Sir Everard Home, Sir Wm. Blizard and Mr. Cline attended him."

In fact, visitors had been admitted long before that day. On 18th May 1813 Clift recorded : " Museum *first opened* to Visitors. To continue every Tuesday and Thursday till the end of June," but a glance through the diaries for 1811 and 1812 will suffice to show that numerous previews had been arranged. " Mr. Harvey of St. Bartholomew's Hospital brought Ten Gentlemen, Students at that Hospital to the Museum " (2nd May, 1811). "A friend of Sir W. Blizard's to see the Museum from America " (17th May, 1811). " Dr Fitzpatrick of Dublin from Sir Wm. Blizard to See the Museum " (25th July, 1811). " Mr. Rush of Philadelphia with Mr. Home to see the Museum " (27th July, 1811). " Dr. Richardson from Edinburgh from Sir William Blizard ; to see the Museum, particularly the morbid preps. . . . Mr. Home and Two Friends " (9th July, 1812). " Lord St. Helens and Friends to see the Museum. Mr Belfour attended them " (6th November, 1812), etc. Even in the *General Report, from the first Board of Curators . . . holden on the 3rd Day of July, 1801* mention is made of visitors. " The Rules respecting Visitors, agreed to by the Court, are calculated for the *present* State, and Situation, of the Collection. Whenever it shall be removed to a Building suitable to the Purposes for which it was planned, and vested ; and becoming the Dignity of the College ; a new System of Regulations will, doubtless, be necessary " (p. 10).

The number of visitors who saw the Hunterian collection as it was displayed in the " temporary Depository," where it remained until 29th September, 1806, when " the Whole of the Collection was reported to be removed, from Castle Street, to the House adjacent to the College " (Curators' reports, p. 72), cannot be ascertained from the Reports of the Curators. Figures are not given until 1813, when 233 persons visited the museum, and the numbers for 1814 and 1815 were 267 and 820 respectively (p. 104).

47

The first visitor mentioned by name in the Reports is the Prince
Regent. " Visitations of the Museum, by illustrious Personages, are
expressive of its national Character, and just Celebrity. The Board,
therefore, recorded, with peculiar Satisfaction, the Visit of HIS ROYAL HIGH-
NESS THE PRINCE REGENT ; on Wednesday, the 28th Day of July, 1813. On
which Occasion, HIS ROYAL HIGHNESS was graciously pleased, to express
Sentiments of Admiration of the Museum ; and of true Estimation of its
Contents " (pp. 102-3). The Board, who, in the General Report of
1801, had declared that they " have been without Precedent, or Example,
for their Guide, excepting the Regulations of the British Museum " (p. 6)
continue their report and look back with deep satisfaction, but no com-
placency, at their achievements of thirteen years. " The Fame of the
collegial Depository will extend to every Nation : and the constant
Exertion of Curators will be necessary, to meet the just Expectation of
Men devoted to Inquiry, relating to natural Knowledge, and the Healing
Art " (p. 103).

A reference is made to the visits of Her Imperial Highness the Grand
" Dutchess " of Oldenburg, Their Imperial Highnesses, the Archdukes
John and Lewis of Austria, " all of whom departed with Acknowledge-
ments of high Gratification " (p. 104), as did lesser visitors, who " ex-
pressed themselves highly sensible of the scientific Character, and
Importance, of the Collection ; the Beauty, and Utility of the Edifice ;
the manifested Designs of the Court ; and the advanced State of its national
Undertakings " (p. 93). "And the Court will learn with Pleasure, that,
upon these Occasions [the Days appointed for Inspection] . . . the obliging
Attentions, and perspicuous Explanations, of the Conservator, have
called forth general Expressions of Approbation " (pp. 104-5). And the
report continues : " But the Court will, at all Times, bear in Mind, that
the Museum of the College, as the Seat of Reference, and Illustration, is
become a permanent Adjunct to the seven Hospitals ; and the various
Schools of Anatomy, and Surgery ; in the System of anatomical and
chirurgical Education, in the Metropolis ; and that it is, therefore, of
national Concern, and demands correspondent Support " (p. 107).

It had indeed become an international concern and the diary of William
Clift bears witness that the collegial depository had extended to every
nation. " Mr Abernethy with Dr. Spurtzheim from Germany " (6th May,
1814). " General Wiebel, Physician to his Majesty the King of Prussia "
(9th June, 1814). " Sir James Wylie, Surgeon to the Emperor of Russia "
(15th June, 1814). " *Dr. Stark* from Vienna to see the Museum. . . . Dr.
Stark said he had examined nearly every accessible Collection of monsters
in Europe. He scarcely noticed any other objects in the Museum. I
thought he was a monstero-maniac " (9th July, 1814). " *Mr. White
Author of a Journal [of a Voyage] to New South Wales.* Formerly Surgeon
to the Settlement. . . . The same gentleman who sent from New Holland
the immense Oran Outang's Skull from Borneo to Sir William [Blizard].

He was acquainted with Mr. Hunter if not a pupil, and corresponded with him " (18th July, 1814). On August 11th, 1814, " *Monsr. de la Mark* accompanied by Mr. Headington and friend [came] to see the Museum, from Sir Wm. Blizard " and on " Sunday morning Aug. 21st [1814]. *Mr. Roux* Surgeon to the Hospital La Charité at Paris with Mr. Brodie. From Sir Everard Home, to see the Museum. Staid *half an hour,* as he had an appointment to see Carlton House with Madame Roux and Madame Boyer." The description of this visit is to be found in Roux's
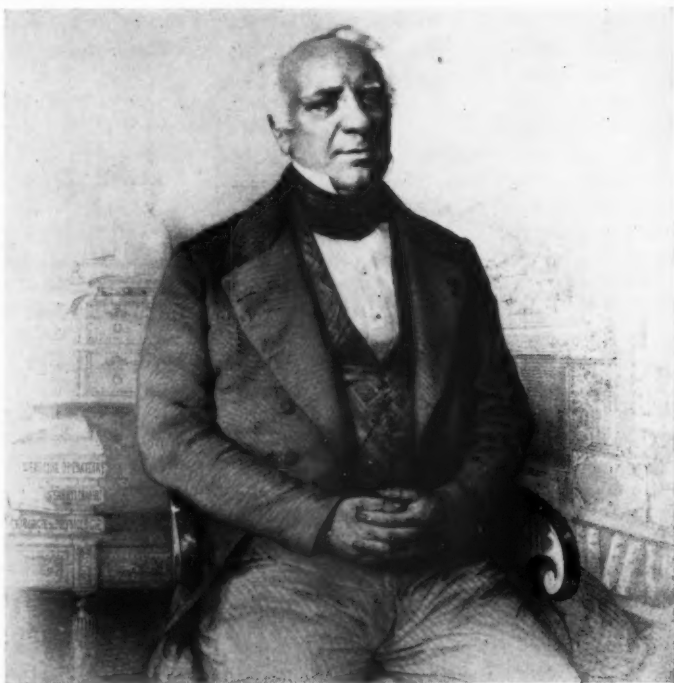
Joseph Philibert Roux
(Lithograph by A. Collette)

own *Relation d'un voyage fait à Londres en 1814*, but, before quoting the French surgeon, whose account is all the more valuable since it gives a picture of the Museum as it was before Dance's building was replaced by a larger one in 1836, let us look at the man and at the book itself.

Philibert Joseph Roux (1780-1854), whom Frédéric Dubois in his *Eloge de M. Roux* (Mémoires de l'Académie impériale de médecine *21*, pp. i-xxxi, 1857) described as " un des plus ingénieux et des plus hardis

praticiens de notre époque ... professeur à la Faculté de Médecine ... et chirurgien en chef de l'Hôtel-Dieu. . . . Doué des plus riches et des plus séduisantes facultés, opérateur habile et consommé, esprit vif, orné, loyal ; avouant ses erreurs et ses revers avec autant d'empressement, j'allais dire avec autant de satisfaction que ses succès et ses triomphes ; caractère noble, généreux et conciliant, homme de goût et de moeurs élégantes "[1], was, with his rival Dupuytren and his father-in-law Boyer, one of the leading French surgeons of the first half of the nineteenth century, and must, at the time, have been one of the most distinguished and learned visitors to the College museum.

Peace had just been signed, and as there was no obstacle to the desire which Roux had felt for a long time of becoming better acquainted with English surgery, and of seeing at close quarters men who enjoyed great celebrity, he betook himself to London in the summer of 1814. In the following year, his book, *Relation d'un voyage fait à Londres en 1814; ou Parallèle de la chirurgie anglaise avec la chirurgie françoise, précédé de Considérations sur les Hôpitaux de Londres,* was published in Paris, where it was warmly received. " Ce livre eut d'autant plus de retentissement que, bien qu'à des époques diverses Morand, Ténon, Chopart et Antoine Dubois eussent visité l'Angleterre, personne encore n'avait publié de renseignements complets sur l'état de la science chez nos voisins "[2] (René Marjolin). " The publication of this work," Marjolin continues, " forged a link between English and French surgery, and one cannot exaggerate the influence which the narration of a few months spent among the most distinguished surgeons of London had on us. Scientific relations, which war had interrupted for so long, were renewed. To the well-known names of Everard Home, Cline, Abernethy, were added those of Astley Cooper, Brodie, Lawrence, Travers and Charles Bell, and soon their valuable contributions became known throughout France." An English translation of the work appeared in 1816, and was reviewed in the June 1816 number of the *Annals of Medicine and Surgery* (with John Cross's *Sketches of the Medical Schools of Paris.* Dublin, 1915) and, in July of the same year, in the *Medico-chirurgical Journal and Review.* A second edition of the work was advertised in the *London Medical and Physical Journal* of September 1816.

Roux divided his narrative into two sections : Part the first : Hospitals, and surgical education in London, and Part the second : Chirurgical

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[1] ". . . one of the most ingenious and fearless practicians of our time . . . professor at the Faculty of Medicine . . . and surgeon-in-chief of the Hôtel-Dieu. . . . Endowed with the noblest and most engaging faculties, a skilful and accomplished surgeon, a keen, fertile and loyal mind ; admitting his mistakes and his failutes with the same eagerness, I would say with the same satisfaction as his successes and his triumphs ; a noble, generous and sympathetic personality, a man of taste and refined manners."

[2] " This book roused great interest since, although at various times Morand, Ténon, Chopart and Antoine Dubois had visited England, no one had yet published a complete account of the state of this science among our neighbours."

doctrine and practice of the English, and preceded them with his Preliminary Observations. " Shall I decide to which of the surgeons, whether French or English, the superiority in point of importance of their discoveries is to be awarded ? No. How can any one be an impartial judge in his own cause ? " (p. 10). " I wished to speak less of ourselves than of our neighbours : I wished to take a rapid glance of all that surgery owes to the English. . . ." (p. 13). " It was not useless for the honour of French surgery, that the English surgeons should have been visited by some one of us capable of appreciating what was doing amongst them, and of inspiring them with sufficient confidence that they might be desirous of learning from him what was going on in France. Already, indeed, and in spite of the short time the communications between the two countries had been established, the prejudices of the English practitioners against the French surgery had been strengthened by the unfaithful reports of some young English medical men, probably some of the pupils who had visited Paris" (p. 16).

What he wrote on fractures, aneurysms or lithotomy must be judged at its intrinsic value by the surgeon, the sole purpose of this paper being to draw attention to what must have been one of the first published accounts of a visit to the College Museum. " Of the two colleges," Roux begins, " I have only seen that of surgery. As an establishment for education, the College of Surgery of London is not to be compared either to our faculties of medicine as they at present exist, or even to what the College of Surgery of Paris was, at the period when this College and the ancient Faculty of Medicine formed two bodies of education distinct from one another. In the London College of Surgery they have only, in the space of a year, one course of Anatomy, one of Surgery, and another of Comparative Anatomy. It is a singular circumstance, that this last course is the most extensive of the three, and that to which they have attached the most importance, and give the greatest attention. Certainly, Comparative Anatomy and Physiology are a part of natural history, which ought to enter into a complete system of medical education. . . . But that in the College of Surgery of London, comparative anatomy and physiology should occupy the first rank, that a course on this subject should be the principal one given there, is an essential defect in this institution. After what has been said, it will not appear astonishing to relate, that the Museum of Anatomy in the College of Surgery of London, which, in other respects, is very beautiful, extremely well arranged, very neatly kept up, and in which is to be found even a profusion, is less a museum of anatomy, such as one would expect to find in a school of surgery, than a kind of collection of natural history, or, at all events, of comparative anatomy. The preparations relating to this latter subject occupy, indeed, the greatest space ; they are arranged according to the order of the functions, that is to say, there are grouped together the organs of each function belonging to all the classes of animals, and this order, they pretend, existed in the museum

51

of their college before M. Cuvier had adopted it for his researches, and
his work on Comparative Anatomy. It is the same method to which
Haller had been led for human anatomy, in his great work on physiology,
almost involuntarily, and without attaching to it any importance : it is
that which Sœmmering, and after him Bichat, introduced into their
works ; a good method in some respects, defective in others, when applied
to human anatomy ; but, applied to comparative anatomy, is the only
plan truly great and philosophic, the only one consistent with the end
proposed in the study of this part of natural history. This anatomical
museum contains, as an appendix, a tolerably large collection of patholo-
gical anatomical preparations, and particularly in the department of
surgery. This collection was formerly that of W. Hunter[3] " (pp. 75-77). And
Roux concludes : " I was only able to take a hasty survey of this beautiful
assemblage of anatomical preparations, properly so called, as well as of
comparative and morbid anatomy : they appeared to me to have been
carefully preserved. I must here take occasion to observe, that the English
appear to possess, to a greater degree than we do, and to partake with the
Germans, the taste for anatomical preparations. In London, the museum
of the College of Surgeons is only more superb than several others which
belong to private professors of anatomy and surgery. The one
which I regarded with the most interest, after that of the college, is one,
which being begun by John Hunter[3], and augmented by the assiduity of
M. M. Wilson and Charles Bell, forms at present a part of the establish-
ment in which these two distinguished men teach anatomy and surgery "
(pp. 77-78).

So wrote Roux of his visit to the College and to its Museum. He only
failed to comprehend why it " is less a museum of anatomy, such as one
would expect to find in a school of surgery, than a kind of collection of
natural history, or, at all events, of comparative anatomy." He mis-
understood what was its *raison d'être* or what has remained one of its
main functions, he saw the specimens, but he missed the Hunterian ideal.

ACKNOWLEDGMENTS

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I have received from Mr. W. R. LeFanu, M.A., Librarian of the College.

REFERENCES

CLIFT, W. (1811-14) *Diaries.*
DUBOIS, F. (1857) *Mém. Acad. Méd. Paris* **21**, 1.
MARJOLIN, R. (1863) *Mém. Soc. Chir. Paris* **5**, 1.
ROUX, P. J. (1816) *A Narrative of a Journey to London, in 1814 ; or a Parallel of the
    English and French Surgery ; preceded by some Observations on the London Hospitals.*
    London.
ROYAL COLLEGE OF SURGEONS IN LONDON   (1822)   *Reports, from the Boards of
    London.   Curators.*
————————————————————————— (1900)   *Souvenir of the centenary . . .*
                                                         1800-1900. London.
————————————————————————— (1940)   *Calendar.* Historical summary.

[3] Roux interchanged William and John Hunter's names.

52

CEREMONY OF PRESENTATION OF DIPLOMAS

THIS ANNUAL CEREMONY was successfully inaugurated on 11th June 1958. By 2.30 p.m. the Great Hall was filled to capacity when the President and Council, headed by the Mace, filed in procession up the length of the Hall to take their places on the dais. In addition to the Council there were represented the Court of Patrons, Court of Examiners, and the Boards of each of the Faculties, all in their appropriate College robes. Those to whom diplomas were to be presented (some 200 in all) included Honorary Fellows, Fellows by Election, Fellows and Members by Examination, Fellows and Licentiates in Dental Surgery and Fellows in the Faculty of Anaesthetists, most of whom had brought relations or friends to witness the ceremony.

The President (Sir James Paterson Ross), opening the meeting, spoke as follows :

I would like you to understand that this is an Extraordinary Meeting of the Council and I am delighted that it is so well attended. My colleagues and I feel that to-day we are making history because this sort of meeting we are having is a new thing, and among my senior colleagues more than one has said to me how good it would have been if Lord Webb-Johnson could have been here because he would have been so interested in this ceremony. Although this is the first meeting of the Council since his death there will be no formal motion of condolence here. That will be done to-morrow at the Ordinary Meeting of the Council, but I am sure it is right that I should say a word just to recall our great debt of gratitude to him for his devoted service and inspiring leadership to the College during long and difficult years, especially while he was President.

The first item on the agenda for the meeting was the admission of Honorary Fellows, and after the Vice-Presidents (Sir Russell Brock and Sir Archibald McIndoe) had escorted Professor C. F. W. Illingworth to the dais, a citation in his honour was given by Professor Ian Aird in the following terms :

Mr. President, I have the honour to present to you Charles Frederick William Illingworth, Commander of The Most Excellent Order of the British Empire, Doctor of Medicine and Master of Surgery of Edinburgh University, Fellow of the Royal College of Surgeons of Edinburgh, and the Royal Faculty of Physicians and Surgeons of Glasgow, and Honorary Fellow of the American College of Surgeons, Regius Professor of Surgery in the University of Glasgow.

As his titles suggest, his career is a tale of two cities. After distinguished service as a fighting pilot in the First World War he proceeded to a medical course in the University of Edinburgh, where he qualified a year before I began my own medical course in the same University. He had already a reputation for high intellectual ability, integrity of character and courtesy of manner. He proceeded to devote himself to a surgical career, which has been uninterrupted by any achievement short of success. His master was the late Sir David Wilkie, and while he was still a neophyte in surgery he already showed in the operating theatre an unhurried economy of movement and of time, a steadfastness of purpose, a gentle and unostentatious dexterity, and an outward placidity of temperament which were modelled on his master, and which were the basis of that skill in practical surgery for which he has long been now famous. But technical skill

53

was the least of Illingworth's attributes. He showed a talent for original investigation which has enabled him to illuminate our knowledge of the surgery of the upper abdomen. When later I myself undertook the study of surgery I sat under Illingworth, as they say in Scotland, in one of the most brilliant lecture courses in surgery that has been undertaken in that city, and which Illingworth brought to perfection in a quiet, unostentatious and factual style which makes not only for lucidity but for a nice and untiring accuracy of description. In due course with an inevitability which was obvious to all who knew him, Illingworth was called to a Chair, the ancient Regius Chair of Surgery in the University of Glasgow. In this Chair Illingworth has carved for himself a timeless monument. He has the rare attribute of being an inspiration to his younger men, and much of his own original ideas are buried anonymously in the work of his pupils. It is as a master of surgery in the broadest sense that I present to you for the conferment of the Honorary Fellowship of the College Charles Frederick William Illingworth.

The President welcoming Professor C. F. W. Illingworth to the Honorary Fellowship, with Sir Archibald McIndoe (Vice-President) looking on.

Professor Illingworth then replied :

Mr. President and Members of the Council, I am most grateful for this opportunity to express my very deep sense of gratitude for the high honour you have just done me. All the world knows that to be admitted as a Fellow of this College after the usual method of examination is a sufficiently meritorious achievement, so much the more so then is the Honorary Fellowship something

to be proud of, and I make no secret of the fact that I am intensely honoured that this should have come my way. I also consider it a tribute to the work of successive groups of younger men who have been working as assistants in my department at Glasgow. I may say that they are just as delighted as I am that this honour has come my way, and I regard it as an honour for them as well as myself, and in their name as well as my own I thank you.

Professor F. L.-P. de G. d'Allaines thanking the College after being admitted to the Honorary Fellowship by the President, who is seen on the left of the picture.

Professor F. L. P. de G. d'Allaines was then presented to the President and Professor Digby Chamberlain honoured him with the following citation :

Professor d'Allaines is well known to many of us, and he is known to us all by repute. He is surgeon to the Hôpital Broussais and Professor of Surgery in the University of Paris. He is a Grand Officer of the Legion d'Honneur and holds the Croix du Guerre. He is a member of the Academy of Medicine and of the Academy of Surgery of Paris, and he is one of the medical members of the Academy of Science of France. He is an honorary fellow of the American College of Surgeons and an honorary doctor of medicine of the University of Utrecht. In this country he is an honorary member of the Surgical Section of the Royal Society of Medicine.

His great surgical contribution was to popularise the conservative method of resection for carcinoma of the rectum, and it is due to his teaching and his

55

writing that surgeons began to interest themselves in this method of treatment in his own country, elsewhere on the continent of Europe and in this country. If we do not commonly employ his exact technique, we did learn from him the important place which conservative resection has in the treatment of this disease. Having seen this work accepted and firmly established he turned his attention to the surgery of the heart and with the help and encouragement of the French Government he has established a centre for it in Paris.

He is regarded by his colleagues in France as the originator and as the greatest exponent of this type of work in his country.

I think we would all agree that it is unique for one man to take the lead in two such different fields.

As a man he is quiet and modest, and it is this, together with his sincerity and his wide interests, which impress his friends, and everyone with whom he comes into contact.

Outside his professional activities, Professor d'Allaines is a delightful host ; he is a collector, as one would expect in a progressive representative of his country, of pictures of the modern French School. In the country around Paris, when he can find the leisure from his other activities, he is a keen and first class shot, and on at least one occasion he has been to India and has shot tigers.

He has an estate in Sologne, south of Paris, which he farms, and like so many surgeons in this country he seems to find relaxation in escaping to the quiet of the country, and to the peaceful activities which are to be found there.

He has been an honoured visitor to this College on many occasions, and it is fitting that he should be able to enter it in his own right as one of us.

Mr. President, I present to you, to receive at your hands the Honorary Fellowship of this College, François Louis Paul De Gaudart d'Allaines.

Professor d'Allaines expressed his thanks for the great honour conferred upon him, beginning his speech in English and concluding it in French.

Next came the admission of three of the Fellows elected this year as being distinguished medical practitioners of at least twenty years' standing and after each had made the required declaration and signed the book of the Bye-Laws, the President addressed them as follows :

Professor Scarff, it gives us very great pleasure to admit you to-day to the Fellowship, because as Director of the Bland-Sutton Institute at the Middlesex Hospital your office commemorates the name of a great former President of this College. We honour you also for your outstanding contribution to the field of cancer research and that has been acknowledged elsewhere by the high office you hold in the British Empire Cancer Campaign. It is therefore with great pleasure that, by the authority and in the name of the Royal College of Surgeons of England, I admit you as a Fellow.

Air Vice-Marshal Neely, we are proud to honour you to-day because we know of your contribution to ophthalmology as it is applied particularly in the Royal Air Force. We know of your special interest in the effect of high altitude flying upon the eye. It is therefore with very great pleasure that we welcome you here to-day, and in the name and by the authority of the Royal College of Surgeons of England, I admit you to the Fellowship.

Professor Wilkinson, you are so well known to many of us that I scarcely think it is necessary to say any word of introduction about you. But now that you have sampled the academic life of many centres in many parts of the world, we are glad that you have returned to London to act as Director of the Eastman Dental Clinic. We are proud to remember that you were for a time a member of our Council. We also thank you for the special help you have given us from time to time. It is with great pleasure that, by the authority and in the name of the Council of this College, I admit you as a Fellow.

56

Air Vice-Marshal Neely replied as follows on behalf of the three elected Fellows :

Mr. President, Members of the Council, Ladies and Gentlemen : Like Bassanio at the most memorable moment of his career, I feel you have bereft me of all words. If I were an Admiral or other member of the Senior and Silent Service I could perhaps call tradition to my aid, or if I were an Army man I would probably have no difficulty in regimenting my scattered thoughts and placing them in some sort of ceremonial order with the tallest on the right and the shortest on the left, or if I were a Professor—like Professor Scarff or Professor Wilkinson who is used to " articulations "—I would have no difficulty, but as you see, I am in the Royal Air Force and somewhat naturally and perhaps, understandably, my thoughts have taken off, so to say, blown like leaves on the winds of wonder, puffed up by pride and now scattered by the cross currents of a dilemma as acute as that which faced Bassanio when he was confronted with

Professor F. C. Wilkinson being admitted by the President to the Fellowship by Election. Professor Scarff and Air Vice-Marshal Neely, also newly-elected Fellows, are standing behind Prof. Wilkinson, and Sir Russell Brock, Vice-President, is on their right.

sudden favour, honour, fortune and happiness. " You have bereft me of all words," he said, " only my blood speaks to you in my veins and there is such confusion in my powers as after some oration fairly spoke."

What oration so fairly spoke, what message more magnanimous, what gesture so generous could we hope to hear or to receive than this address of election to this Royal College. This Foundation, whose prestige and fame extends throughout the world ; whose roots are dug deep in to the history of this country and on the ability of whose surgeons depends and has depended the wellbeing and the lives of so many of our famous men.

In this regard my thoughts would turn to those of the Service rather than to famous figures such as Edward VII. I have been wondering what would have

57

5

happened to England if the amputation on Nelson's arm, criticised as being technically rather poor(but how difficult an amputation must have been under those circumstances), had led to gangrene, septicaemia and death. Or what might have happened in the case of the Army if so many of her Generals of the last war had not recovered from their wounds received in the First World War. In my own Service one could instance Douglas Bader, who after his flying accident was so far down the pathway leading to eternity that if it had not been for prompt and efficient surgery, he would not have been able to re-tread the highway which led to his own victory over disability, and the victory of England in the Battle of Britain.

You can see, therefore, that it is with a sense of great pride, coupled with humbleness of heart that we three find ourselves associated with the great surgeons of to-day and of yesterday. And on behalf of Professor Scarff and Professor Wilkinson, the Royal Air Force and myself, I would like to express our profound appreciation of this high honour and to say that we will always honour most highly the customs, the traditions and the great name of this, the Royal College of Surgeons of England.

The President presenting Mrs. Sheila M. Crawshaw with her Diploma of Membership.

The Council then received the list of those candidates who had been successful in the recent Final Examination for the Fellowship, and granted diplomas of Fellowship to them on the motion of Mr. A. Dickson Wright, the present Chairman of the Court of Examiners.

Members of the Council and others who were to present candidates for their diplomas then left their seats at the front of the Hall and moved back to join the parties of diplomates from their own medical and dental

schools. There ensued 48 processions, Members of the Council presenting the Fellows, Members of the Court of Examiners the Members, and the Fellows and Licentiates in Dental Surgery and Fellows in the Faculty of Anaesthetists being presented by members of the appropriate Board of Faculty.

Professor Illingworth, by request of the Council, then addressed the new diplomates :

You have charged me, Sir, with a very important duty, to address the new diplomates, the more important in that, as you have told us, this is the first occasion that a ceremony of this sort has been held. For myself it is a very particular privilege because I did not expect it, and in some ways I would have preferred to be in the audience rather than here on the platform. However, I do admit that in two respects I have certain qualities that fit me to this task. In the first place (*addressing Prof. d'Allaines*) I am senior to you in the records of this College by about five minutes, and in the second place I can see for myself that we are all rather on top of our form today, rather honoured by the importance of this great occasion, rather elevated by the significance of today's event, and, if the truth were known, rather inflated by a sense of our own importance, and so in these ways I can speak to you not so much as an elder statesman but rather as a senior diplomate, and speak to you fully aware of the dignity and solemnity of the occasion, at any rate more or less on equal terms.

To the new Fellows I would offer my very sincere congratulations. You have all had a long apprenticeship of many years. You have now succeeded in passing what is generally regarded as one of the most difficult examinations in this field, but now you have got your award, you have attained the rank and status which will open doors in the surgical world in the future.

To the new Members, Licentiates and Fellows in Anaesthetics and Dental Surgery, also I would offer my congratulations. You too have undergone a long training especially in medicine in a long, and some of us think far too long, and tedious curriculum, but now you also have achieved your purpose and you are ready to go out and practise in whatever walk of life in medical or surgical course you want. Some of you I see have come from overseas and I hope that when you return to your own countries you will take with you pleasant memories of your stay in England. Many of you will be asked your views about the work you have already done here, and I would like to refer to some recent correspondence I have had with someone from abroad. I was asked to give him some information on two points. In the first place, what kind of examination this Conjoint was and what were the chances of getting through, and secondly could I recommend him a good, short, cheap, and easily read and not too profound text-book of surgery. My answer was clear. I wrote back and told him that the Conjoint examination was second to none, and with regard to the text-book he should get nothing less than the best.

In more serious vein, I would like to say to all of you new diplomates a few words about your future careers because as I have no doubt you have been told already you are at a cross-roads. It is terribly important for you to decide how you are going to plan your future work. I think a medical career is like hill climbing. We start off across the moors and bogs of pre-clinical work, then over stones where for every step forward we seem to take two steps back : we eventually come upon rock and feel a firm foothold at last ; now engaged on clinical studies the path is much steeper and more hazardous, but we have the thrill of open air and the exhilaration of adventure. Eventually we reach the summit where we think we can rest and relax for a while : then we begin to look round and to our dismay even the summit is not quite the top and others, sometimes more than one, lie ahead. The question arises whether you are content to stay where you

59

are or whether you will tackle the higher summits. Often there is a difficult descent to the col before starting again, and often we stick in a difficult patch and are not quite certain whether when we get to the top it is not a rather cold and inhospitable kind of place. You should not stop where you are, you must go on to the excitement and fun and thrill of life in the adventure of the tasks ahead and you must go on until you get to the ultimate summit or as near to it as you can and thus for your future years I do commend you to your future labours.

Professor Illingworth was thanked by the senior Vice-President (Sir Russell Brock) for his address, and the President then drew the meeting to a close.

GRANT OF FELLOWSHIP DIPLOMAS

AT THE RECENT Final Examination for the Fellowship three candidates out of 13 were successful in Ophthalmology, seven candidates out of 25 in Otolaryngology, and 96 out of 315 in General Surgery.

At a meeting of the Council on 11th June 1958 Diplomas of Fellowship were granted to the following :

NORTHCROFT, George Bernard (*The London*)
THOMPSON, Valerie Mary (*Royal Free*)
ASHBY, William Bennett (*Liverpool*)
SNEATH, Rodney Saville (*Sheffield*)
COFFIN, Frank Robert (*Middlesex*)
BUCKLE, Antony Edward Robin (*Guy's*)
DIGGORY, Peter Lionel Carr (*University College*)
GILLESPIE, Alan (*University College*)
MOYNIHAN, Francis John (*University College*)
POWLEY, John Michael (*King's College*)
PRYN, William John (*Guy's*)
MILLAR, Douglas Malcolm (*St. George's*)
POOL, Kenneth Raymond Stanley (*King's College*)
CALNE, Roy Yorke (*Guy's*)
BEARN, Andrew Russell (*Middlesex*)
JAMES, Richard (*University College*)
BOULTER, Patrick Stewart (*Guy's*)
HAYES, George (*Durham*)
MUTCH, John (*Middlesex*)
MIKHAIL, Ishaq Khalil (*Beirut*)
CHOWDHURY, Abani Kumar (*Calcutta*)
LEES, William (*Glasgow*)
McCLUSKEY, Kenneth Alan (*St. Bartholomew's*)
MENON, Konthath Achutha (*Madras*)
FOWLER-WRIGHT, Joan Yolande (*Royal Free*)
HARROP-GRIFFITHS, Hilton (*Wales*)
HARRIS, Nigel Henry (*Middlesex*)
LEWIS, Ronald Hugh (*Wales*)
PETTY, Alfred Holdsworth (*Durham*)
BLOOR, Kenneth (*Manchester*)
BROWN, Hugh Goundry (*Durham*)
EL-GAILANI, Tahrir Ismail (*Baghdad*)
MAGRI, Joseph (*Malta*)
†MILNER, George Algernon Webb (*Aberdeen*)
†ROHAN, Raymond France (*St. Bartholomew's*)
†SARDANA, Dharmendra Singha (*Lucknow*)
*WALKER, Colin Burleigh (*St. Thomas's*)
ALIMCHANDANI, Kamla Rupchand (*Bombay*)
DHARMAGE, Don Sreemon (*Ceylon*)
DOWSE, John Leighton Anthony (*Wales*)
GRAY, John Gowan (*Edinburgh*)

GRANT OF FELLOWSHIP DIPLOMAS

GRIGG, Graeme Lindsay (*Melbourne*)
JAIN, Adish Chandra (*Lucknow*)
KHANNA, Kailash Nath (*Punjab*)
RAJAKARUNA, Mahasen Lakshman (*Ceylon*)
RASANAYAKAM, Veluppillai (*Ceylon*)
†ROUSSEAUX, Georges Émile (*Oxford*)
WILLIAMS, Edward John (*The London*)
ADAMS, James Arnold (*Cape Town*)
*CHATTERJEE, Sakti Das (*Calcutta*)
COX, Martin Henry (*Cape Town*)
CURRIE, John Campbell Miraumont (*St. Bartholomew's*)
ENGLAND, Ernest James (*Adelaide*)
†FULLER, Alan Pearce (*St. Bartholomew's*)
HAGAN, Brian Elwin (*Sydney*)
HODGKINSON, Anthony Hugh Taylor (*Sydney*)
HOWETT, Robert Anthony (*Melbourne*)
KAPLAN, Isidore (*Cape Town*)
†KELHAM, Bernard Harold (*King's College*)
LEAROYD, Harry Meldrum (*Sydney*)
MANN, Charles Victor (*St. Thomas's*)
MARSTON, Jeffery Adrian Priestley (*St. Thomas's*)
MAVALANKAR, Vishnu Ganesh (*Bombay*)
MORAN, John (*St. Thomas's*)
PATEL, Dahyabhai Chhotabhai (*Bombay*)
ROBIN, Gordon Cyril (*Glasgow*)
TAIT, Ivan Ballantyne (*Edinburgh*)
WALKER, Leo James (*New Zealand*)
WILLIAMS, John Hunter (*New Zealand*)
ATTARD, Raphael (*Malta*)
CHURCHILL-DAVIDSON, Dudley (*St. Thomas's*)
GIRLING, James Arthur (*St. Bartholomew's*)
HUMPHRIS, Philip Blake (*Sydney*)
MITRA, Sudhansu Ranjan (*Calcutta*)
NAIR, Satish Kumar (*Agra*)
O'CONNOR, Brian Thomas (*Queensland*)
PERRY, Kenneth Cyril (*St. Mary's*)
PROUDMAN, William David (*Adelaide*)
*RAAD, Graham Raymond Albert (*Melbourne*)
ROBINSON, Maurice Patrick (*Middlesex*)
SANDER, John Frederick (*Sydney*)
SOUVLIS, Lucas (*Queensland*)
SRINIVASAN, Hari Haran (*Madras*)
VIRMANI, Prem (*Delhi*)
YONG, Nen Khiong (*Malaya*)
DAS, Lakshman (*Patna*)
†JEEJEEBHOY, Homi Feroze (*The London*)
JOHNSTON, Ivan David Alexander (*Belfast*)
KODWAVWALA, Mohamed Yusuf Dawood (*Bombay*)
MAGUIRE, Maurice Glen (*Adelaide*)
MAURICE, Brian Armstead (*St. Thomas's*)
O'SULLIVAN, Denis Christopher (*Cork*)
PAULL, Colin Gordon (*Adelaide*)
ROSS, John Graham (*St. Bartholomew's*)
SINGH, Surendra Bahadur (*Patna*)
SOLOMON, John Ridley (*Sydney*)
CAM, Donald Edmund (*Sydney*)
CRAIG, Robert Dominic Peter (*Manchester*)
DESAI, Ashitbaran Ramanlal (*Bombay*)
LANGFORD, Keith Howard (*Melbourne*)
MENELAUS, Malcolm Benbow (*Melbourne*)
SILVERTON, Robert Peter (*Sydney*)
SMITH, Robert Gordon (*Sydney*)
DAWSON, John Leonard (*King's College*)

* In Ophthalmology   † In Otolaryngology.

61

IMPERIAL CANCER RESEARCH FUND

THE ANNUAL GENERAL MEETING of the Imperial Cancer Research Fund was held at the Royal College of Surgeons on 29th April 1958. In the unavoidable absence of the President, the Rt. Hon. the Earl of Halifax, the Chair was taken by the Chairman, Sir Cecil Wakeley, Bt. The meeting was attended by many Governors of the Fund, and members of the Jack Buchanan Memorial Fund Committee were also present by invitation.

Sir Cecil Wakeley presented the Fund's Annual Report for the year 1956/57. He announced the appointment of Professor G. F. Marrian, F.R.S., Professor of Chemistry in Relation to Medicine at the University of Edinburgh, to the newly-created post of Director of Research. Professor Marrian would take up his full-time appointment in the autumn of 1959. He would be actively engaged in the planning and staffing of the new laboratories and would eventually have charge of all the Fund's research work at both Lincoln's Inn Fields and Mill Hill. Referring to the new laboratories, the Chairman said that after much patient negotiation the Minister of Housing and Local Government and the London County Council had, after consultation with the Fine Arts Commission, agreed to the demolition of 44, 45 and 46, Lincoln's Inn Fields and the preliminary plans for the new building. Detailed plans, which had been deferred until the Minister's decision was known, were now being rapidly prepared and he hoped that in 1961 the Annual General Meeting would be taking place in the Fund's own building. He welcomed Professor G. Payling Wright to the Council in place of Sir Charles Lovatt Evans who, after over twenty years' unfailing service, had felt that the time had come for him to retire.

The Honorary Treasurer, in presenting the annual accounts, welcomed to the meeting many friends of the Fund who were actively working for it.

Sir Cecil Wakeley, Bt., Chairman of Council, addressing the audience at the Annual General Meeting of the Imperial Cancer Research Fund. *Left to right* : Professor Robert Platt, President of the Royal College of Physicians ; Professor Sir James Paterson Ross, President of the Royal College of Surgeons of England ; Sir Cecil Wakeley, Bt., Chairman of Council, Imperial Cancer Research Fund ; Mr. Kennedy Cassels, Secretary of the Fund ; and Mr. A. Dickson Wright, Hon. Treasurer of the Fund.

Mr. Stephen Mitchell, Chairman of the Jack Buchanan Memorial Fund, handing
Sir Cecil Wakeley a cheque on behalf of the Jack Buchanan Memorial Fund.

These included the Earl of Scarbrough, Lord Brocket, and representatives
from the Preston and the Newport Cancer Research Committees. He
said that there had been a gratifying increase in the Fund's income for
the past year and that the surplus had been set aside for the new building.

The Building Fund now stood at over £300,000 but as yet only one-
third of the money necessary had been received and a further £600,000
would need to be raised before the new building was paid for. The
Honorary Treasurer referred warmly to the generous bequests which the
Fund had received under wills and regretted that the Government had not
yet seen fit to extend to bequests the principle which it already admitted
in the case of subscriptions under covenant. Often when a supporter
bequeathed his residuary estate to the Fund, the rate of estate duty was
such that finally only a comparatively small amount remained for the
Fund's use in cancer research. He felt that there was a strong case for
relief from estate duty in such circumstances.

In thanking all the Fund's contributors he wished particularly to
mention Mrs. Jack Buchanan and the Jack Buchanan Memorial Fund
Committee who, under its Chairman, Mr. Stephen Mitchell, had raised
over £14,000 for the endowment of laboratories in the new building ; the
hard work of Mr. and Mrs. Joe Davis who had through their own efforts
raised over £4,000 for the Fund : and the generosity of all those who had
bought tickets and taken advertising space for the special performance of
" My Fair Lady " in aid of the Fund (the Fund benefited by a net amount
of over £14,000 from this performance).

In Memoriam

LORD WEBB-JOHNSON,
G.C.V.O., C.B.E., D.S.O., T.D., F.R.C.S.
(1880-1958)

ONLY A FEW weeks have passed since we read in the May number of the ANNALS a tribute from Alfred Webb-Johnson to his old friend " Jimmy " Allen of Boston, U.S.A. To some who were aware of the state of Alfred's own health this seemed a public *au revoir* to the comrade whom death had taken ; nor were these two friends destined to be separated long. Yet Alfred clung to life tenaciously, and even when seemingly at death's door he suddenly demanded a pen and inscribed a number of reprints of the "Allen obituary tribute " with his own hand and in affectionate terms—a last wave of the hand in farewell to some of his friends.

He was born in 1880 at Stoke-on-Trent, and I have heard from others who knew him in his early days that he owed much to a remarkable

Lord Webb-Johnson

mother : he incorporated her maiden surname in his own name and I recall how a reference to her in a speech of mine on an occasion produced a very grateful and genuinely appreciative letter from him that selfsame evening.

His surgical background was a sound one—Thorburn, Whitehead, Wright, of the Manchester School, and on coming to Middlesex Hospital he fell under the spell of Bland-Sutton and became one of the latter's greatest friends. Before the first war he had visited the urological clinics of Vienna, Berlin and Berne.

A keen officer of the Territorial Force, he was sent to Boulogne in the earliest days of the 1914-18 War, and those no longer young will automatically associate his name with the famous 14th General Hospital, Wimereux, where he first worked as a surgeon and where he later was its commanding officer. In the last year of the war he shared with Andrew Fullerton the duties of consultant surgeon in the Boulogne area.

He had developed an interest in bricks and mortar during his earliest years at " Middlesex," displaying a genius in this direction that never left him, but his flair for organization and administration first showed itself on active service.

Luck may have brushed him with her wings in the opportunities that presented themselves to him : the rebuilding of Middlesex Hospital, the restoration and enlargement of the shattered College of Surgeons : the additions to the Royal Society of Medicine : but he seized opportunity with eagerness and with both hands.

At the close of the Second World War the great post-graduate medical centres of Europe were no longer in a condition to attract surgical pilgrims, and Webb-Johnson seized the occasion to endeavour to make London the post-graduate surgical Mecca. He had already obtained financial aid for a professorship in pathology and also in anatomy, as well as the Baron Research Chair, and now he inaugurated courses of teaching in the basic sciences within the College. He had for long dreamed of a residential hall for surgical post-graduates from overseas and in our midst, an "All Souls " of surgery, as he termed it. The generosity of Lord Nuffield enabled these dreams to come to reality, and the building bears the name of " The Nuffield College of Surgical Sciences."

The length of time during which he held the office of Dean at Middlesex Hospital familiarised him with the problems of undergraduate medical education, and he obtained by his own efforts financial support for the endowment of professorial chairs in the medical school : but it was in the field of post-graduate surgical education that " Webb-J." showed best his vision, his executive ability and unremitting energy to achieve what he had set out to attain.

He possessed the vision to bring the dental surgeons and the anaesthetists under the aegis of the College by instituting a Faculty of Dental

Surgery in 1947 and a Faculty of Anaesthetists in 1948, and he was later elected an Honorary Fellow of each of these Faculties, and a Webb-Johnson Commemoration Lecture pays annual tribute to the man who had played the master rôle in the creation of the Dental Faculty.

Lord Webb-Johnson was indeed one " who walked with Kings nor lost the common touch " ; his friends were legion. His business acumen led to his membership or chairmanship of bodies as dissimilar as the Royal Medical Benevolent Fund, Epsom College or the directorate of the Savoy. He was a patron of the arts, often seen at Covent Garden ; he knew the art galleries of France and Italy as well as the treasures of the National Gallery and " The Tate " : his long Presidency of the College gave him almost automatically a seat at the Annual Royal Academy Banquet.

He had a knowledge of the best literature, and a remarkable memory for phrases as well as faces. He was a devoted " Kiplingite," for Kipling had been his friend as well as his patient.

A connoisseur of silver, he had a special pride in the silver treasures of the College of Surgeons, and there must be many who look back with pleasure on his discourses on the silver at the monthly dinners which he instituted for all those with any attachment to the College and for the visitor in our midst. In his Presidential office and on the public platform he never read an address, nor have I ever seen a note or *aide memoire*. He was a charming host, an entertaining conversationalist ; he combined a strange medley of the emotional and the intransigent, at one moment a tear or a sob punctuating his discourse, and at another time revealing the *sang-froid* of a political pachyderm towards the barbs of those who ventured to be his hostile critics. The dignity and aplomb which he brought to the presidential chair were greatly enhanced by the charm and graciousness of Lady Webb-Johnson, who so loyally and conscientiously accompanied him on every great occasion. In the years of failing health he transferred his chief interests to securing an appropriate setting for what remained of Hunter's collection after the " blitz " and to the work of the Hunterian Trustees, paying almost daily visits to Lincoln's Inn Fields. His great interest in this work was shown in a practical manner by the generous MacRae-Webb-Johnson Gift.

He served a record number of years as President of the College. With his great gifts it is perhaps surprising that he did not remain in that proud position even longer ; nevertheless by reason of his leadership and achievement posterity may acclaim his presidency as the greatest of all time, for he has left behind him a hive of industry and enthusiasm in Lincoln's Inn Fields, and he gave a soul to what had hitherto been little more than a famous museum and a rendezvous for examiners and surgical aspirants.

G. G.-T.

ON EXAMINING JOHN HUNTER'S
PATHOLOGICAL SPECIMENS

by

L. W. Proger, M.A., M.R.C.S., L.R.C.P.

Curator of the Wellcome Museum of Pathology, Royal College of Surgeons of England

As IN THE past, so to-day specimens from John Hunter's original museum are still used to illustrate new developments and their re-examination by modern methods often provides striking evidence of their value.

In 1882 Sir Frederick Eve read a paper to the Medical Society of London on the striated muscle tumours of the kidney in children, which had first been described some ten years earlier. At the time Eve was assisting Sir James Paget with the preparation of the 2nd Edition of the Catalogue, and searched the collection for another example of the tumour. He found one amongst the Hunterian specimens and although this had been preserved in spirit for at least 90 years, he was able to demonstrate striated tumour cells in histological sections.

In 1908 Professor Shattock was studying the similar embryonic tumours of the bladder and was also able to match his specimens with an original Hunter preparation. He was also able to demonstrate the characteristic microscopic appearance in spite of an even greater lapse of time. Unfortunately, the original sections have not been preserved, but when these two specimens were used to illustrate a recent lecture on the subject (Proger, 1957), the tissues were re-examined histologically and showed the characteristic microscopic structure with remarkable clarity.

In 1949 when Professor R. I. Harris, of Toronto, delivered his Hunterian lecture on spondylolisthesis, he recognised a Hunterian specimen in the ankylosis series of the museum as an example of a " talocalcaneal bridge " —a congenital deformity which he had described as one of the contributory causes of peroneal spastic flat foot. He was able to add photographs and X-rays of this specimen to his series. In a recent letter he states that he has received photographs of another example recovered from the temple tomb of a Mayan prince in Guatemala.

A more recent enquiry has been received from Dr. G. P. T. Barclay, who is making a study of a series of cases of renal vein thrombosis complicating amyloidosis of the kidney. In reviewing the literature he finds that one of the earliest accounts is given in Dr. W. Howship Dickinson's book on renal and urinary affections (1885).

Dickinson quotes a case of John Hunter's—Lady Beauchamp—who died with renal vein thrombosis following a long exhausting illness with a discharging sinus in the region of the hip joint. He concludes that " whether or not lardaceous change had as yet resulted, the blood had probably been considerably modified by the suppurative drain."

Lady Beauchamp's kidney is still preserved and it has been possible to

obtain remarkably good histological sections in order to settle the question. Although there is no evidence of amyloid disease, the sections clearly show the widespread thrombosis of the veins. The tissue also contains clumps of large Gram positive bacteria which, in the absence of any cellular response, indicate the post mortem invasion of the body by clostridial organisms, commonly occurring after long wasting illnesses. As Sir Stanford Cade observed, these sections demonstrate the presence of bacteria in the tissues many years before the discovery of bacteria as the cause of disease.

It is not known why Hunter preserved these particular specimens, but they give an example of his wide range of interest. He was in the habit of preserving specimens which caught his attention in the hope that they would provide valuable information when better methods of investigation became available.

That these hopes are still being fulfilled provides a stimulus for further examination of this remarkable collection.

REFERENCES

DICKINSON, W. H. (1885) *On renal and urinary affections.* London, Longmans.
EVE, F. G. (1882) *Trans. Path. Soc. Lond.* **33**, 312.
HARRIS. R. I. (1951) *Ann. Roy. Coll. Surg. Engl.* **8**, 259.
PROGER, L. W. (1957) *Erasmus Wilson Demonstration, R.C.S.,* unpublished.
SHATTOCK, S. G. (1909) *Proc. Roy. Soc. Med.* **3**, 31.

HONOURS CONFERRED ON FELLOWS AND MEMBERS

J. D. McLAGGAN, C.V.O., F.R.C.S.	K.C.V.O.
B. T. EDYE, C.B.E., F.R.C.S.	K.B.E.
E. W. RICHES, M.C., F.R.C.S.	K.B.E.
R. M. MORRIS, O.B.E., M.R.C.S.	C.M.G.
J. CROOKS, F.R.C.S.	C.V.O.
D. A. WILSON, F.F.R., M.R.C.S.	C.B.E.
C. S. HALLPIKE, F.R.S., F.R.C.P., F.R.C.S.	C.B.E.
D. H. D. BURBRIDGE, M.R.C.S.	O.B.E.
R. M. LLOYD STILL, M.R.C.S.	O.B.E.
L. M. O'HANLON, M.R.C.S.	O.B.E.
E. B. WILD, F.R.C.S.ED., M.R.C.S.ENG.	O.B.E.
A. S. GARRETT, M.R.C.S.	M.B.E.

ANATOMICAL MUSEUM

THE SPECIAL DISPLAY for the month of July consists of specimens showing John Hunter's discoveries.

PROCEEDINGS OF THE COUNCIL IN JUNE

AT A MEETING of the Council on 12th June 1958, with Professor Sir James Paterson Ross, President, in the Chair, a resolution of condolence was passed on the death of Lord Webb-Johnson, past President of the College.

The following were co-opted to the Council for the year 1958-59, representing various branches of practice :

General Practice	—	Dr. John Hunt
Anaesthetics	—	Dr. Frankis Evans
Ophthalmology	—	Mr. T. Keith Lyle
Gynaecology & Obstetrics	—	Mr. A. C. H. Bell
Radiology	—	Professor D. W. Smithers
Otolaryngology	—	Mr. C. Gill-Carey
Dental Surgery	—	Sir Wilfred Fish.

Mr. D. Ioan-Jones and Mr. T. G. I. James were re-elected members of the Court of Examiners for a further period of three years. Examiners for the year 1958-59 were elected.

The Hallett Prize was awarded to Miss M. V. Ramchandani of the University of Bombay.

A Diploma of Fellowship was granted to H. F. Jeejeebhoy and a Diploma of Fellowship in Dental Surgery was granted to D. G. Gould.

The following hospitals were recognised under paragraph 23 of the F.R.C.S. regulations :

HOSPITALS	POSTS RECOGNISED		
	General (all 6 mths.)	Casualty (all 6 mths.)	Unspecified (all 6 mths.)
N. IRELAND—Lurgan and Porta-down Hospital	S.H.O. H.S.		
N. IRELAND — Musgrave Park Hospital	S.H.O.		Regr. (Gen. and Thoracic Surg.)
NORTHAMPTON — General Hospital (Additional)			*Under paragraph* 23(c) Ophth. Regr. Ophth. H.S.

SAYINGS OF THE GREAT

" No man can be a good physician who has no knowledge of operative surgery, and a surgeon is nothing if ignorant of medicine ; a knowledge of both branches is essential."   *Lanfranchi (d.* 1306)

" In criticizing the ignorance of the dark ages or the middle ages, modern writers often forget how very ignorant we ourselves are, or how recent is our knowledge."   *Sir Norman Moore* (1847-1922)

" Lawyers are the cleverest men, the ministers are the most learned, and the doctors are the most sensible."   *Oliver Wendell Holmes* (1809-94)

(Contributions are invited.)

PROVINCIAL MEETING IN CARDIFF

26th-27th September, 1958

FELLOWS AND MEMBERS are again reminded that the Annual Meeting this year will be held in Cardiff on Saturday, 27th September, and will be preceded by a Dinner for Fellows and Members and their medical guests on the evening of Friday, 26th September.

The full programme will be published in the August issue of the ANNALS but it can now be announced that, during the afternoon session, Sir Russell Brain will deliver a lecture on " The Cervical Spine." He will be admitted to the Honorary Fellowship of the College during the meeting.

Those who are intending to be present at the meeting are asked to make it known to as many Fellows and Members in their own regions as possible ; and in particular they are advised to reserve accommodation, if they require it, at one of the following hotels in Cardiff *at the earliest possible moment,* since reservations will not be held open for more than a few days : The Park, The Angel, The Queens, The Royal.

DIARY FOR JULY

Wed. 16		D.O. Examination and D.T.M. and H. Examination begin.
Thur. 17		Final F.F.A. Examination and D.Phys.Med. Examination (Part I) begin.
Fri 18		Annual General Meeting and election of Licentiate to the Board of Faculty of Dental Surgery.
	4.00	PROF. H. G. RADDEN—Charles Tomes Lecture—Local factors in healing of the alveolar tissues.*
		Anniversary Dinner of Faculty of Dental Surgery.
Sat. 19	10.30	Board of Faculty of Dental Surgery.
Wed. 23		D.Phys.Med. Examination (Part II) begins.
Fri. 25	4.30	DR. WILLIS POTTS—Moynihan Lecture—Respiratory emergencies in the new born.*
		Basic Sciences Lectures and Demonstrations for Dental Students end.
Thur. 31	2.00	Ordinary Council.

DIARY FOR AUGUST

Sat. 2		College closed.
Mon. 4		College closed.

There will be no lectures at the College during August, but the Museum and Library will remain open.

* Not part of courses.

70

2

MALIGNANT TESTICULAR TUMOURS

Colonel Robert Alexander Stephen, O.B.E., M.D.(Aberd.), F.R.C.S.
Consulting Surgeon, Far East Land Forces

THIS IS A survey of 100 primary malignant tumours of testicles. All the patients belonged to the Services and with three exceptions were treated at the Malignant Disease Centre for the Army in the Queen Alexandra Military Hospital, Millbank, during the ten year period from July, 1947 to June, 1957.

Following simple orchidectomy, all patients, with twelve exceptions, were given two full courses of deep X-ray therapy to the abdominal lymph nodes over a period of four months, as described by Cade (1952). This was done at the Westminster Hospital under the direction of Sir Stanford Cade and Dr. F. M. Allchin.

Forty patients were transferred with all speed by air evacuation from Commands overseas to Millbank to avoid any delay in the application of deep X-ray therapy. The following is a typical example. Seven days after a patient in Singapore had reported to his unit medical officer for the first time, he was at the Westminster Clinic in London ready for his first dose of prophylactic deep X-ray therapy, having had his testis removed and the diagnosis of malignant tumour confirmed histologically.

I was in charge of the Army Malignant Disease Centre for four years of the period under review. During that time I did thirty-four of the orchidectomies personally and was responsible for the after-care and follow-up of another forty-two patients who had been transferred for deep X-ray therapy from other military hospitals after orchidectomy.

Histologically forty-nine of the tumours were seminomas and fifty-one teratomas. The teratomatous group included three chorion epitheliomas and eight " combined " types of teratomas, as described by Cairns (1926) in his Hunterian Lecture on this subject, that is a teratoma combined with a seminoma in the same testis. The high incidence of teratomatous tumours is attributed to the preponderance of young National Servicemen in this series. Thirty-three of the patients were between seventeen and twenty-one years of age at the onset of their symptoms. During training they were subjected to considerable physical stress which brought to light the early symptoms and signs of testicular tumours.

Three of the ninety-seven patients had bilateral tumours.

The initial diagnosis was wrong on fifty-six occasions. The correct diagnosis was not established for over a year in fifteen cases. In spite of that, five patients survived for five years. The different histological

71

groups were all equally difficult to diagnose. Fortunately, in the Services, the majority of these errors did not delay treatment unduly as the patients were referred to hospital immediately for further treatment. A few, however, were told they had nothing to worry about and having been reassured they did not seek further medical advice until symptoms arising from metastases made their appearance.

The significance of trauma

In the aetiology of testicular tumours trauma seems to have played a minimal part. Its incidence was proportionately distributed amongst the various histological groups. Nineteen patients gave a definite history of having received a direct blow of some magnitude on the affected testicle. Yet only five of them complained of sickening testicular pain at the time of injury giving rise to the diagnostic cry of the crushed testis, while three others complained of a dull ache only. This indicates that most if not all of the affected testis had already been destroyed by unsuspected tumour growth in the remaining eleven who sought medical advice on account of a painless testicular swelling. It seems most unlikely that trauma initiates tumour growth. The following case is of interest :

A young athlete (aged 18 years) split his testis on the cross-bar while pole-vaulting. Fortunately what was considered to be a gross haematoma was explored surgically and not left to nature. A small haematocele was found with a longitudinal split in the tunica albuginea through which tissue was seen, like fine mincemeat. The testis was three times the size of its neighbour. It was removed and was found pathologically to contain a combined teratoma.

In fifteen of the patients, the size of the tumour at the time of orchidectomy was about double that of a normal testis while in four it was even much larger. The increased bulk made them much more liable to be injured. Four of the young men with teratomas almost certainly had an unsuspected testicular tumour, which had already given rise to metastases before the injury was sustained.

Should a suspensory bandage be worn to relieve pain following trauma, in the presence of an unrecognised tumour, the semeniferous tubules will undergo destruction through pressure atrophy and so the pain will be relieved. There will be loss of testicular sensation and loss of the chance of early diagnosis.

Histologically only six tumours associated with injury showed evidence of recent haemorrhage because of the great delay in orchidectomy.

Trauma, apart from having delayed orchidectomy through the tumours being misdiagnosed, probably expedited the spread of metastases physically. Six of the nine patients available for five-year survival assessment survived free of disease. The three fatal cases ran a hurricane course and died within six months of onset. They all had metastases before orchidectomy. The enlarged testis had been noted immediately after injury. Early orchidectomy followed by prophylactic deep X-ray therapy

72

is of great importance after a malignant tumour has been injured because of the risk of injury spreading metastases.

The significance of mal-descent

In over 9,000,000 army recruits Campbell (1942) showed the incidence of cryptorchidism to be 0.23 per cent. In this series 4 per cent. of the 100 tumours occurred in mal-descended testes. None of these was intra-abdominal.

Six patients in all gave a history of cryptorchidism. In two of them, the mal-descended testis, situated in the inguinal canal, remained free of disease while the normally descended gonad in the scrotum developed a tumour. One tumour was a seminoma whilst the other was a teratoma.

A tumour developed in the mal-descended testis itself in the remaining four patients. One of the tumours was a seminoma and the other three were teratomas. One of the teratomas developed in a forty-two-year-old patient, twenty-seven years after the testis had been placed in scrotum surgically. Another teratoma was detected six years after an orchidopexy, when the scrotum was explored, following injury, to exclude torsion of the testis. The remaining two tumours grew in testes lying at the external inguinal ring. Both gave rise to pain in the groin. One of the testes was associated with an oblique inguinal hernia and at operation was found to be small and atrophic. It was removed and sent for a pathological opinion which established the diagnosis.

Out of the six mal-descended testes therefore two escaped malignant growths while their neighbours developed tumours. Two developed tumours after being placed in the scrotum surgically while the remaining two when left alone at the external ring also gave rise to tumours.

The average age of patient at onset of tumour growth

The age of onset of the growth is probably about the same in the different histological types of tumour, but the patient with the slower growing seminoma is usually older before he becomes aware of his tumour.

TABLE I
AVERAGE AGE OF ONSET IN YEARS

Histological groups			Seminoma	Teratoma	Combined teratoma	Chorion epithelioma
Total number of tumours	..	..	49	40	8	3
Average age	..	..	31	23	21	26
Extreme range of ages	..	..	19-49	18-44	17-35	19-41
Majority ranged between	..	..	26-37	18-26	17-24	19-20
Peak age of incidence	..	..	28-30	19-21	17-18	19-20

These figures are five years below those quoted by most writers (for example, Gordon-Taylor and Till, 1938, and Sauer, et al., 1948). These

patients therefore were aware of their testicular tumours at an earlier age than in other published series. This has provided an opportunity of studying the early symptoms and signs of the onset of the diseases.

Symptomatology

Ninety-two patients first became aware of swelling of one testicle. One third of them noticed the testis also felt heavy. Four of the ninety-two patients complained of pain in the groin but in only thirteen instances was the testis itself painful at first, i.e., seventy-five patients found the swelling of the testicle painless.

Throughout this series a painless swelling of a testis was the one and only symptom or sign of any value in the early diagnosis of a testicular tumour—for instance :

An Officer Cadet (aged nineteen) while performing full duty, attended a routine health inspection. He was found to have a tumour of one of his testicles. It measured 32cm. in circumference and was associated with huge abdominal metastases. His scrotum had been enlarged for eight months yet he had no complaints.

After a time eighteen of the seventy-five patients with a painless swelling of the testis sought medical advice on account of pain, either in the testis or in the groin, so that altogether thirty-five patients complained of pain.

In twenty-five instances the tumour was large and appeared to have caused the pain, through dragging on the spermatic cord. Two of these patients when first seen already had distant metastases. This type of pain must therefore be regarded as a late symptom of tumour growth.

The remaining ten patients who felt testicular pain or discomfort had small tumours. The pain had drawn attention to the previously unnoticed swelling. In three of the ten patients the pain followed injury. The pain appeared to have been due to rapid tumour growth or to haemorrhage from the growth into the surrounding testicular tissue before all the semeniferous tubules were destroyed by growth, otherwise the testis would have been insensitive.

Histological examination of the specimens from five of these ten patients showed haemorrhages of varying degrees within the tumours. Pain associated with a small tumour indicates active growth. There was no difference between the seminomas and teratomas. That accounts for ninety-two of the patients.

Of the remaining eight patients not one was aware of the tumour. The first abnormality noticed arose from secondary metastases. Five complained of backache, two noticed enlargement of the breasts while the eighth patient was admitted to hospital with acute intestinal obstruction.

Correlation between histology and clinical course

TABLE II

DISTRIBUTION OF HISTOLOGICAL TYPES OF TUMOUR OVER THE VARIOUS CLINICAL COURSES

	Total tumours	Seminoma		Teratoma		Combined teratoma		Chorion epithelioma	
Histological distribution	100	49	(15)	40	(16)	8	(6)	3	(3)
I. Insidious course	60	31	(7)	24	(7)	4	(3)	1	(1)
II. Hurricane course	12	4	(4)	5	(5)	2	(2)	1	(1)
III. Pseudo-inflammatory course	5	4	(2)	—	—	1	(1)	—	—
IV. Chronic course	15	8	(1)	6	(1)	1	—	—	—
V. Unobtrusive primary :									
i Abdominal symptoms	1	—	—	—	—	—	—	1	(1)
ii Backache	5	2	(1)	3	(2)	—	—	—	—
iii Gynaecomasty	2	—	—	2	(1)	—	—	—	—

NOTE.—The figures in brackets indicate the number of deaths in each group.

Table II shows the very even distribution of the different histological types over the five clinical courses, in proportion to the total number of each type. The terms applied to the clinical courses are based on those coined by Sir Gordon Gordon-Taylor and Wyndham (1947) namely—Insidious, Hurricane, Pseudo-Inflammatory, Chronic and Unobtrusive Primary.

I. An Insidious Course extends over a period of months to years and eventually gives rise to metastases, if untreated. 60 per cent. followed this course and eighteen patients died.

II. A Hurricane Course is characterized by a rapid growth of the primary with early symptomless metastases which kill the host within a year, in spite of treatment. Military patients had the primary tumours excised before they reached the gigantic dimensions recorded by Gordon-Taylor and Wyndham (1947), but even so, all twelve following this course died.

III. A Pseudo-Inflammatory Course runs a very acute phase with local testicular pain and tenderness closely simulating acute epididymitis. Only five patients pursued this course. Four of them had a seminoma and three died.

IV. A Chronic Course, of slow growth, extends over at least two years before the rate of growth suddenly accelerates and gives rise to a vast tumour simulating the text book description of a malignant testicular tumour which is therefore more easily recognised. If untreated it eventually gives rise to metastases. Ten of the fifteen patients considered the tumour had grown three times as large as normal within one month, yet eight of these ten survived for five years. Therefore rapid growth is not in itself fatal.

V. An Unobtrusive Primary Growth is minute and symptomless but gives rise to a multiplicity of metastases which rapidly dominate the clinical picture. For example they may present with an abdominal syndrome, suddenly simulating an acute abdomen or with severe backache

or even with gynaecomasty. Death occurs very rapidly because the metastases are so widespread before the disease is recognised and treatment begun. Only two patients with seminomas belonged to this group, all the others had teratomas.

The following is a typical case history of a patient with an Unobtrusive Primary :

A Lance-Corporal (aged twenty-two) had a small primary testicular tumour which remained undetected for many months. Severe back-ache had rendered him unfit to drive a lorry. An orthopaedic surgeon treated him intermittently for over a year, diagnosing the condition as a prolapsed intervertebral disc. An attack of sub-acute intestinal obstruction with epigastric pain and vomiting drew attention to the mass of enlarged, hard, para-aortic lymph nodes, secondary to a small teratoma of testis.

TABLE III

THE FIRST SYMPTOM OR SIGN ARISING FROM METASTASES

Site of metastases Nature of first symptom or sign	No. of patients	Seminoma	Teratoma	Combined teratoma	Chorion epithelioma
1. Para-aortic lymph nodes	31				
(a) Backache	12	7	4	—	1
(b) Pain in groin	6	2	2	2	—
(c) Intestinal colic	3	—	2	—	1
(d) Symptomless	10	6	3	1	—
2. Supra-clavicular ymph nodes..	2				
Lump in neck	2	2	—	—	—
3. Pulmonary (seen on X-ray)	13				
(a) Haemoptysis	1	—	—	1	—
(b) Breathlessness	1	—	—	1	—
(c) Symptomless	11	2	7	1	1
Total number of tumours ..	46	19	18	6	3

Table III shows the nature of the first symptom or sign arising from metastases along with the histological distribution and incidence over the three common sites.

TABLE IV

INTERVAL BETWEEN ONSET OF PRIMARY AND SECONDARY SYMPTOMS

Interval	Total patients	Seminoma	Teratoma	Combined teratoma	Chorion epithelioma
Under six months ..	14	4	7	2	1
Six months to two years ..	7	4	1	2	—
Two to five years ..	3	3	—	—	—
Five to eight years ..	1	1	—	—	—
Total	25	12	8	4	1

Table IV shows the interval between onset of primary and secondary symptoms as found amongst twenty-five patients who developed metastases out of a total of fifty who were available for five-year survival assessment.

All the teratomas that gave rise to metastases did so within six months of the onset of symptoms, with one exception. In contrast one third of the seminomas metastasized within six months, another third between six months and two years, while the remaining third varied between two and eight years. Combined teratomas occupied an intermediate position, between the teratomas and seminomas.

The average delay in orchidectomy from the onset of symptoms, amongst the same fifty patients, was worked out to see if there was much difference in the interval between those who survived and those who died of metastases.

TABLE V
AVERAGE DELAY IN ORCHIDECTOMY
A—Delay less than one year—42 patients

Histological type of tumour	Survived five years		Died within five years	
	No. of patients	Delay in months	No. of patients	Delay in months
Seminoma	14	4	7	5
Teratoma	10	2½	8	4
Combined teratoma	—	—	2	2
Chorion epithelioma	—	—	1	5

B—Delay over one year—8 patients

Histological type of tumour	Survived five years		Died within five years	
	No. of patients	Delay in years	No. of patients	Delay in years
Seminoma	5*	4	1	4
Teratoma	—	—	—	—
Combined teratoma	—	—	2	2
Chorion epithelioma	—	—	—	—

*One died six years and another eight years after onset of symptoms.

Table V is in two parts—Part A and Part B. Part A shows forty-two patients where the delay was less than one year. Since the interval was over one year with eight patients, these have been shown in Part B, because the long periods of delay amongst these few gave a very false picture for the others.

From this Table it is very obvious that any delay in diagnosis leading to delay in orchidectomy plays a major part in the patient's chances of survival. For example, with seminoma the delay was four months amongst the fourteen survivors and five months amongst the seven who died, while with teratomas the delay was two and a half months amongst the ten survivors and four months amongst the eight who died. There were no

survivors amongst the other varieties. Part B shows that early orchidectomy might well nigh have saved the lives of five patients.

Much of the delay was due to failure of the patient to seek medical advice early. The rest was due to diagnostic errors in which the malignant nature of the lesions was not recognised in their early stages. This is well illustrated as follows :

A recruit (aged twenty) at his very first physical training drill in the Army had to " fall out " because of breathlessness and the drag of a heavy, painless testicular tumour. Two years before enlistment he had been reassured by his civilian doctor that the small lump in his scrotum was nothing to worry about. For these two years he had been able to continue his work as an apprentice shoemaker. His teratoma had metastasized widely before enlistment.

From a review of the above studies it appears that patients with seminomas were on the average eight years older than those with teratomas. The seminomas tended to grow more slowly and took longer on the average to give rise to metastases.

The effects of combined surgical and radiotherapy treatment

These show steady progress since the beginning of the century when Russel Howard (1907) published the survival rate as 5.5 per cent. after two years, following simple orchidectomy. Radical orchidectomy which aimed at removing the affected testicle and its associated lymphatic drainage area complete in one piece was introduced into this country by Sir John Bland Sutton (1909) but did not meet with the success that was expected. Jamieson and Dobson (1910) explained this by showing that the lymphatic drainage area was so widespread and inaccessible that any really radical operation was well-nigh impossible. With careful selection of cases, the survival rate, according to Cairns (1926) rose to over 30 per cent. Gordon-Taylor and Till (1938) showed a survival rate of 37 per cent. This improvement in the survival rate was due to the introduction of deep X-ray therapy, as a therapeutic measure, applied immediately after simple orchidectomy. Along with Wyndham, Gordon-Taylor (1947) with further experience in deep X-ray therapy raised the survival rate to 44 per cent. over a five-year period. This shows that radiation therapy is a most potent and valuable adjunct to orchidectomy. The present series of fifty patients available for five-year survival assessment from the time of onset of symptoms shows 54 per cent. survived free of disease.

TABLE VI

NUMBERS AVAILABLE FOR FIVE YEAR SURVIVAL RATE ASSESSMENT FOLLOWING ORCHIDECTOMY AND PROPHYLACTIC RADIOTHERAPY

	No. of patients	Seminoma	Teratoma	Combined teratoma	Chorion epithelioma
Clinically free of metastases at orchidectomy	34	20 (15)	13 (10)	—	1
Pre-operative metastases present	16	7 (2)	5	4	—

NOTE.—The figures in brackets indicate the numbers of survivors (all in good health.)

78

Table VI demonstrates clearly the effect of early orchidectomy followed by adequate prophylactic radiotherapy before the spread of metastases is obvious clinically or radiologically.

Of the thirty-four patients free of disease at orchidectomy 75 per cent. of those with seminomas and 77 per cent. of those with teratomas survived, while of the sixteen with pre-operative metastases 28.5 per cent. of those with seminomas and none of the others survived. This gives an overall survival rate of 63 per cent. for seminomas and 56 per cent. for the others. None of the combined teratomas or chorion epitheliomas survived.

The post-radiation prognosis depends on the following observations. All the patients with pre-operative metastases who died did so within eighteen months of orchidectomy. All those who appeared free of metastases at operation but subsequently developed them did so within eighteen months. Therefore if a patient, after orchidectomy and a full course of deep X-ray therapy, survives for eighteen months and is free from metastases it seems reasonable to presume that he has a good chance of survival.

An analysis of the twenty-three fatal cases showed that ten of them died within four months of orchidectomy. Pre-operative metastases were so widespread that only palliative courses of irradiation to relieve troublesome symptoms such as severe backache were possible. Of the thirteen who died in spite of orchidectomy and a full course of deep X-ray therapy, seven died within the first year of operation, three within the second year, two within the third year and one within the fourth year.

TABLE VII

THE AVERAGE DURATION OF DISEASE IN FATAL CASES

Seminoma	..	..	..	..	3 years
Teratoma	..	..	..	..	1¼ years
Combined teratoma		..	..	..	2 years
Chorion epithelioma		..	..	..	5 months

The periods recorded in Table VII have been reckoned from the onset of symptoms until death. All the fatal cases have been included whether they had a full course of radiotherapy or only a palliative course.

The effect of irradiation was that most metastases were very sensitive and clinically disappeared completely. Unfortunately fresh crops of radio-resistant metastases appeared and with two exceptions eventually killed the patient. In both exceptions the tumour was a seminoma.

Radiation therapy has improved the prognosis in testicular neoplasms to an extraordinary degree provided a full course of prophylactic irradiation is given to the abdominal lymph nodes immediately after orchidectomy.

Due to the prolongation of life from early orchidectomy followed by a full course of deep X-ray therapy three patients have survived long enough to have bilateral testicular tumours. Such cases may well be more frequent in the future. Five were seminomas and one was a teratoma. The intervals between orchidectomies were seven years, nineteen months and five months.

7

None of the tumours gave rise to metastases. For a time each patient had considerable difficulty in deciding whether or not his remaining testicle was increasing in size as he had no neighbour with which to compare it.

REVIEW OF 100 TESTICULAR TUMOURS

Thickening of the spermatic cord

In this review some degree of thickening of the spermatic cord was detected clinically in twenty-three patients. In none of them was any thickening of the vas deferens found, either general thickening or nodular thickening. This is a very important point in the differential diagnosis from chronic infective lesions of the epididymis. Exposure of the cord at operation showed that the thickening was due to increased vascularity of the cord and hypertrophy of the cremasteric muscle. With the exception of four cases, the tumour masses equalled or far exceeded three times the size of a normal testis, and in half had already given rise to metastases, irrespective of their histology. Thickening of the spermatic cord should therefore be regarded as a late clinical sign. Only one patient had histological evidence of malignant cells in what appeared to be a thickened cord, clinically. Another patient with an apparently normal cord, clinically, had malignant cells in the veins and lymphatics of the cord. He already had metastases in his abdominal lymph nodes.

Incidence of hydroceles

The incidence of hydroceles was not marked, as only eighteen patients had this abnormality. All of them were small with thin walls and contained not more than two ounces of clear straw-coloured fluid. No large hydrocele was found associated with a malignant tumour. This is in accordance with the observation of John Hunter (1835) who never saw a large secondary hydrocele with a testicular tumour. With one exception, these small hydroceles accompanied large tumour masses. Half of these tumours had already given rise to metastases.

Size of tumour

Comparison of size of the various tumours was difficult to assess because of cysts, haemorrhages and irregularly shaped tumour masses. The normal average testicle was taken as measuring $4 \times 3 \times 2$ cms. and weighing 48 grammes. A rough clinical guess was made by comparing the tumour mass with the normal neighbouring testis using the following scale :

Small	.. ..	Not more than one and a half times normal
Moderate	..	Between one and a half and twice normal
Large	.. ..	Any measurement over twice normal

There was a wide range of sizes in each histological group. The largest combined teratoma weighed 500 grammes while the largest seminoma weighed 465 grammes. Unfortunately the largest teratoma had not been

weighed but from its measurement it was probably about the same weight. Post-operatively, on section, the small tumours were much larger than they appeared to be clinically.

From a study of the fifty patients available for five-year survival assessment, it is obvious that the size of the tumour is no indication as to whether or not it has given rise to metastases. Forty of them had large tumours at orchidectomy and over half of these had metastasized. Another five tumours were small but even then four had metastases. Four of the remaining five patients with moderately-sized tumours survived the full period of five years without metastases.

Consistency of tumour

The consistency of the tumour mass was recorded clinically in eighty-two instances. It was hard in four-fifths of them and firm in the remaining fifth, while in two the testis felt so normal that the tumour was not detected clinically in the early stages. Three-quarters of the patients with firm tumours, available for five-year survival assessment, survived free of disease, while only half of those with hard tumours survived. The prognosis therefore is slightly better when the tumour is firm rather than hard whether it be a seminoma or a teratoma. Cysts could be palpated in twelve of the large teratomas.

Surface of tumour

The state of the surface of the tumour was recorded in sixty-five cases. In forty the surface was irregular while it was smooth in the remaining twenty-five. Only one small seminoma was smooth as against six out of ten small teratomas. The reason for this was that the small teratomas tend to be centrally placed in the testis and covered with normal testicular tissue so that they felt almost like a normal testicle. None of the combined teratomas or chorion epitheliomas had smooth surfaces as they were all large tumours when diagnosed.

Location of tumour

The location of the tumour in the testis was recorded in forty-five instances. In most large tumours so little, if any, of the testis could be identified clinically that it was impossible to decide from which part of it the tumour had originated. In twenty-one testes the tumour was in the upper pole. It was in the anterior border in three cases and within the posterior border at the hilum in five. One patient had two separate tumours, both seminomas, in the same testis resembling an hour-glass. On section there was a tumour, one centimeter in diameter, at each pole with normal testis between them. The remaining one-third of the forty-five tumours were located at the lower pole.

Testicular sensation

The presence or absence of testicular sensation was recorded pre-operatively in seventy-seven cases. In twenty-one of these the tumour

81

mass was completely insensitive to moderate digital pressure. In for y-four others practically normal sensation was felt over a small limited ar a, while the rest of the tumour mass was insensitive. On section a small a ea containing normal semeniferous tubules was found in two-thirds of the e. In a further seven patients, a dulled sensation was elicited all over the tumour. It was interesting to find on section that these tumours were surrounded by a thin rim of normal compressed testis. In the remaining five testes, sensation was normal and unimpaired clinically. Each of the five, on section, was found to contain a small tumour surrounded by normal semeniferous tubules. Sensation was dependent on the presence of these normal tubules and was not affected by the histological type of the tumour.

Urinary hormone assay

This was not studied specially. Positive results invariably indicated a grave prognosis but fourteen negative results occurred although the patients already had palpable abdominal metastases.

DIFFICULTIES IN DIAGNOSIS

In nineteen patients the lesion was at first thought to be in the epididymis, instead of in the testis. This error was made with all five of the tumours which ran a pseudo-inflammatory course and also with the five small tumours located on the posterior testicular border at the hilum. The latter simulated chronic tuberculous epididymitis very closely. Two others were assumed to be old post-gonococcal lesions, while the remaining seven were considered to be non-specific. Clinical differentiation between the various lesions may be quite impossible without undue delay, so that early surgical exploration is justified. The very real difficulty in diagnosis is well illustrated :

A Private (aged nineteen) after two months' observation in Hong Kong, on account of an ache in a testicle, was evacuated to Millbank and correctly diagnosed as a teratoma testis. There, three senior surgeons agreed unanimously that the lesion was almost certainly tuberculous in origin. After wasting six weeks on laboratory investigations surgical exploration exposed a small teratoma lying within the posterior border of the testicles alongside a normal epididymis. Fortunately the patient is still free of metastases.

A further example was a Staff Sergeant dispenser (aged twenty-three) who had an undiagnosed teratoma for two years in spite of having consulted a number of different medical officers at the hospital he worked in. His painless testicular swelling was labelled as a non-specific epididymitis after a venereologist had excluded a gonococcal lesion. Since he had access to drugs the possibility of concealing gonorrhoea had been considered. Eventually he was admitted to hospital on account of a persistent cough, pleuritic pain, pyrexia and loss of weight. A physician noted a pleural effusion and mistook his large testicular tumour for a tuberculous epididymitis with a large hydrocele and thickened spermatic cord. The complete loss of testicular sensation was noted but its significance was not appreciated. A surgical opinion was not sought until the

administration of anti-tuberculous treatment had failed to improve his condition and further check X-rays of his lungs revealed " cannon ball " metastases.

Two clinical points may help to prevent such mistakes :

(a) The testis containing a small tumour usually lies lower in the scrotum than normal, while inflammatory lesions involving the spermatic cord raise the testis.

(b) It is important to compare, by very careful palpation, the vas deferens and cord on one side with those of the other. If the vas on the affected side is thickened a tumour is most unlikely.

A misdiagnosis of hydrocele was the second most common mistake. This was so with eleven patients of whom only two actually had hydroceles and both of these were small ones. Nearly all the tumours with hydroceles were large tumours. An added difficulty was that a few of the large teratomas contained soft palpable cysts which closely resembled localised hydroceles. On aspiration glairy viscid fluid was obtained from three of them. The following examples suffice to illustrate the difficulty :

A Captain (aged twenty-seven), R.A.M.C., consulted a senior surgical colleague on account of an idiopathic hydrocele. Eighteen months later, the same surgeon was horrified when he found a solid teratoma which measured 12·5 centimetres in diameter.

The second example was :

A Warrant Officer (aged forty-one) who had a seminoma which weighed 465 grammes and measured 13·5 cms. in diameter. Three years previously he had been told that the painless swelling of his testicle was a hydrocele. During these three years a number of medical officers agreed with the diagnosis but no surgical opinion was sought and no tapping was carried out. He was a keen polo player and had to strap his tumour on to his abdominal wall to keep it off the saddle. Eventually a surgeon saw him because of an attack of subacute intestinal obstruction. The correct diagnosis was obvious. At orchidectomy no hydrocele was present.

A similar history was given by a Captain (aged forty) who was a very keen fencer. Eight years previously he had consulted a medical officer on account of a small hard swelling in the lower pole of his testicle. He had been given a suspensory bandage. During the ensuing years he had been seen by a number of doctors but his scrotal lump had not been diagnosed correctly until he had a large tumour which affected his balance while fencing. It was a seminoma.

The third most common mistake was to diagnose a tumour as a haematoma or haematocele. In ten patients the lesion was at first thought to be a haematocele. With no history of injury the presence of a haematocele should suggest a neoplasm immediately. With a history of injury the assessment of the degree of pain suffered is most important. If the pain was less than might be expected from the violence of the blow, destruction of the testis by tumour growth should be excluded by surgical exploration.

The key to the identification of a scrotal swelling is the position of the epididymis. Stretched out behind a large tumour or concealed by even a small haematocele it is impalpable. In these circumstances it is then

83

necessary to trace the vas deferens downwards as far as possible to orientate the scrotal contents and decide whether or not any firm or hard area is part of the testicle.

The following two case records illustrate the difficulty in diagnosis :

A Major (aged thirty-six) complained of a painless swelling in one of his testicles three days after receiving a football injury. This was diagnosed as a haematoma and it appeared to resolve slowly for a few months. A year after the injury, the scrotum again began to swell. A small hydrocele was aspirated. The underlying testicle was felt to be harder than normal but was regarded as an organised haematoma. A further year passed before orchidectomy showed the presence of a huge seminoma.

The second case was a Staff Sergeant (aged twenty-eight), who was a physical training instructor. He received an accidental blow on a testicle. Three days later he felt a dull ache in the testicle and noticed it was enlarged and harder than normal. For ten days the ache increased. He was treated in hospital for two weeks as having a haematoma. The swelling got smaller but never returned to normal. One year later he was selected for the physical training display at the Royal Tournament, Olympia, but had to withdraw because the swing of his large seminoma upset his balance on the horizontal bar.

The following errors were less common : three patients were seen on account of discomfort from an inguinal hernia. In addition to the hernia each had a testicular tumour which had not been detected by the unit medical officer. At operation one of the three testes was atrophic. It aroused the surgeon's suspicions. He removed it and the pathologist found a teratoma.

Next there were two patients each having had an undescended testicle placed in the scrotum some years before. They presented a difficult clinical problem because some of these transplanted testes atrophy. The problem was, whether or not the testis was an enlarged atrophic one due to tumour growth or a normal testis.

Another error was made when a testicular tumour was mistaken for torsion of the testicle after injury. The loss of sensation was thought to be due to tubular necrosis from anoxia. Immediate surgical exploration led to orchidectomy.

In another patient a tentative diagnosis of a cyst of the paradidymis was made in error. Actually he had a minute malignant teratoma of testis on the edge of a partially organised haematoma which measured 2cm. in diameter. The tumour itself was the smallest tumour in the series. It measured 3m.m. in diameter.

In nine further patients the primary tumour was overlooked. Symptoms arising from the metastatic deposits resulted in the following mistakes in diagnosis being made :

(i) Prolapsed intervertebral discs	..	..	..	..	..	3
(ii) Retroperitoneal sarcoma	..	..	..	..	..	2
(iii) Acute intestinal obstruction	..	..	..	..	..	1
(iv) Renal calculus	..	..	..	..	..	1
(v) Subacute appendicitis	..	..	..	..	..	1
(vi) Gynaecomasty	..	..	..	..	..	1

Orchidectomy was carried out for benign lesions on eight occasions, not included in this series. The naked eye appearances and the feel of the exposed testis at operation were not sufficient to exclude a neoplasm so orchidectomy was performed. Later, histological examination established the diagnosis as follows :

(i) Two mal-developed testes with defective efferent systems.

(ii) Two densely fibrosed and one calcified lesion of the epididymis due to old infections.

(iii) One filarial infection in which a dead adult worm lay in an abscess cavity between the hilum of the testis and the epididymis.

(iv) One torsion of the testis following trauma and leading to anoxic necrosis of the semeniferous tubules.

(v) One haematoma of testis with complete disorganisation of testis but no evidence of malignant disease.

In none of the above was a functioning testis removed.

DISCUSSION

Early diagnosis of a testicular neoplasm followed by immediate orchidectomy and adequate post-operative radiotherapy gives the patient a very good chance of survival provided metastases are not present. Early diagnosis is dependent on recognition of the clinical picture. The growth appears as a firm or hard, painless swelling within the body of the testis. Normal testicular sensation remains until the continuous tumour growth compresses or destroys more and more of the semeniferous tubules. Their destruction lessens the intensity of the sickening pain normally felt when a testis is injured. At the same time the additional bulk of even the smallest tumour increases its vulnerability. Further tumour growth may involve the tunica albuginea and give rise to a small hydrocele. This does not occur if the growth retains a central position within the testis.

Testicular pain, unconnected with injury, indicates active tumour growth with bleeding into the tumour substance and is a danger signal that spread by metastatic deposits is imminent.

In my experience the following method of examining the testis is the best way of avoiding mistakes. The whole testis is palpated throughout with the greatest delicacy of touch. This is done most easily between the index finger and thumb of both hands simultaneously. If the soft feel of the normal testis is not elicited throughout, a malignant tumour must be suspected until it has been proved to be innocent. The sensitivity of the testicular tissue to digital pressure must also be assessed. If a very small tumour is present its hardness may be not felt because of the cushioning effect of the normal testicular tissue covering it. Any minute nodule projecting through the surface and associated with an underlying area of increased resistance is almost certainly malignant. The only really difficult area to palpate is the posterior border of the testis where the hilum abuts on the body of the epididymis. Unless the associated

85

vas deferens is thickened, surgical exploration is invariably requir d here to decide whether a small lump arises in the testis or in the epididym s. Thickening of the vas practically excludes a tumour.

The methods of detecting abdominal metastases are also of great importance as a guide to the prognosis. Detection of metastases in the iliac or para-aortic lymph nodes may be extremely difficult. It is facilitated by examining the abdomen with the patient's knees and hips flexed and supported. Where no epigastric masses can be palpated, an intravenous pyelogram may show slight lateral displacement of the upper parts of the ureters, due to hidden metastases. Further examination under anaesthesia, using muscle relaxant drugs, should precede operation, because the detection of metastases calls for immediate orchidectomy without exploration of the scrotal contents. The size of the tumour is no guide to the presence or absence of metastases.

OPERATIVE PROCEDURE

When the testicular tumour is obviously malignant, the first step in orchidectomy, using an inguinal incision, is to double clamp the spermatic cord at the abdominal ring and divide it with a diathermy knife, before delivering the testicular tumour into the wound. This procedure lessens the risk of spreading metastases.

One patient, with a seminoma, had malignant cells in his spermatic cord, close to where it was divided by a diathermy knife. After therapeutic deep X-ray therapy, he survived five years, free of disease and was doing full duty. In contrast, the only two instances of local recurrence occurred when a diathermy knife was not used to section the spermatic cord. One patient had a seminoma while the other had a teratoma. Both died with metastases later. Unnecessary radiation risks to the remaining gonad are run if the cord is left in the inguinal canal through dividing it at the subcutaneous ring instead of at the abdominal one.

The scrotum should first be explored when the diagnosis is not clearly defined and there is difficulty in deciding whether or not orchidectomy is required. Such is the case when a surgeon is unable to decide whether a hard or firm lump in the scrotum is or is not within the testicle. Difficulty may also arise in the presence of a haematoma that masks a testicle which failed to give rise to sickening pain at the time of injury and in which sensation is diminished or absent. Before starting the exploration it is a wise precaution to have the patient's written consent to orchidectomy should the need arise. A scrotal incision gives adequate access. If there is any abnormality within the testis or any doubt about the innocence of the lesion, extend the incision into the groin and remove the whole organ intact along with the spermatic cord up to the abdominal ring. This gives an accurate diagnosis, safely and quickly. There is no place for a limited biopsy of any kind. That is far too dangerous, because the piece of tissue obtained may not contain tumour although a tumour is present and once the tunica albuginea is opened the tumour may

86

spread locally with great speed. That happened to a patient with a teratoma who had a biopsy done. Within ten days the growth had fungated through the skin where it had been incised and it had grown rapidly along the track from which the drainage tube had been removed.

CONCLUSION

Without resort to more powerful forms of irradiation, with all their potential dangers, we already have at hand a more simple and much safer means of improving the chances of survival, namely, earlier diagnosis through careful clinical examination of the patient.

Outside teaching hospitals, few doctors see more than two or three testicular tumours in a lifetime, so that other more common scrotal lesions are apt to be diagnosed at first, in error. The resulting delay may cost the patient his best chance of survival as the tumour may metastasise in the interval. Any swelling of the testis itself should be referred to a surgeon at once with a view to exploration, because it may be impossible to decide by palpation alone whether a small swelling lies in the posterior border of the testis or in the epididymis. An insensitive testicle should be excised as it is functionless and may be dangerous.

The tragedy of seeing so many young men die helplessly from metastases made me vow never to leave a questionable swelling of scrotum unexplored. Early diagnosis is of the utmost importance.

SUMMARY

A review of 100 testicular tumours observed during a ten-year period is presented. Pre-operative metastases occurred in thirty. The average age of the patient at the onset of symptoms was thirty-one years with seminomas and twenty-three with teratomas. The early symptoms and clinical findings are recorded. The difficulties of differential diagnosis and management are discussed. Of the thirty-four patients without evidence of metastases who were eligible for five-year survival rate assessment, 75 per cent. with seminomas and 77 per cent. with teratomas survived. Of the sixteen with pre-operative metastases only two with seminomas survived.

ACKNOWLEDGMENTS

My thanks to Sir Stanford Cade are not only personal but also on behalf of the whole medical service of the Army. We appreciate greatly the part he has played, down through the years, in carrying on the happy liaison between the Westminster Hospital and the Army so fortunately initiated by George James Guthrie at the beginning of the last century.

REFERENCES

BLAND-SUTTON, J. (1909) *Lancet* **2**, 1406.
CADE, Sir S. (1952) *Malignant disease and its treatment by radium.* 2nd edition **4**, 99. Wright, Bristol.
CAIRNS, H. W. B. (1926) *Lancet* **1**, 847, 849.
CAMPBELL, H. E. (1942) *Arch. Surg. (Chicago)* **44**, 360.
GORDON-TAYLOR, G., and TILL, A. S. (1938) *Brit. J. Urol.* **10**, 4, 40.
———————— and WYNDHAM, N. R. (1947) *Brit. J. Surg.* **35**, 11, 16.
HOWARD, R. J. (1907) *Practitioner* **79**, 794.
HUNTER, J. (1835) *Works*, edited by J. F. Palmer. London **1**, 469.
JAMIESON, J. K., and DOBSON, J. F. (1910) *Lancet* **1**, 493.
SAUER, H. R., WATSON, E. M., and BURKE, E. M. (1948) *Surg. Gynec. Obstet.* **86**,592.

COUNCIL ELECTION 1958

ON THURSDAY, 3rd July, Mr. Eric W. Riches, M.C., and Sir Arthur Porritt, K.C.V.O., were re-elected and Mr. F. W. Holdsworth and Mr. J. Cridlan Barrett, V.C., T.D., were elected Members of the Council of the College.

The result of the Poll was as follows :

Elected	Votes
Mr. Eric W. Riches, M.C. (re-elected) (Middlesex Hospital)	1,337
Sir Arthur Porritt, K.C.M.G., K.C.V.O., C.B.E. (re-elected) (St. Mary's Hospital)	1,176
Mr. F. W. Holdsworth (elected) (Sheffield Royal Infirmary)	974
Mr. J. C. Barrett, V.C., T.D. (elected) (Leicester Royal Infirmary)	857
Not elected	
Mr. R. H. Maingot (Royal Free Hospital)	801
Mr. E. G. Muir (King's College Hospital)	758
Mr. A. H. Whyte, D.S.O., T.D. (Royal Victoria Hospital, Newcastle-upon-Tyne)	748
Mr. L. N. Pyrah (Leeds General Infirmary)	663
Mr. R. V. Cooke (Bristol Royal Hospital)	626
Mr. D. W. C. Northfield (The London Hospital)	594

In all 2,424 Fellows voted, and in addition 26 votes were found to be invalid and 50 arrived too late.

DONATIONS

THE FOLLOWING GENEROUS donations have been received during the past month :

Appeals Fund

£270   Proceeds from sale of gifts from W. R. Gibson.

£105   G. H. Thomas.

£100   Sir Alan and Lady Tod.

£1,000 p.a. for ten years under covenant.   Dunlop Rubber Co. Ltd.

Department of Dental Science

£250   D. & W. Gibbs, Ltd.

Chair for Great Hall

E. Freshman.

THE MANAGEMENT OF
RUPTURED INTRACRANIAL ANEURYSM*

Hunterian Lecture delivered at the Royal College of Surgeons of England

on

24th January 1957

by

F. John Gillingham, M.B.E., F.R.C.S., F.R.C.S.(Ed.)
Consultant Neurosurgeon to the Royal Infirmary, Edinburgh
Senior Lecturer in Surgical Neurology, University of Edinburgh

JOHN HUNTER'S INTEREST in aneurysms was not only confined to those of the popliteal artery. I am fortunate in having a copy of one of his case records which describes a patient whom he saw in 1791. This was a unique case of a sixty-eight-year-old woman with bilateral intracranial aneurysms arising from the carotid arteries. There were symptoms and signs of fluctuating distension of these sacs with attacks of headache, diplopia, and dimness of vision. After her death in 1792 autopsy was performed by his brother, William Hunter, in the presence of Dr. Jenner and himself. He describes two large aneurysmal sacs about five-eighths of an inch in diameter, lying on either side of the sella turcica. They have been preserved in the Hunterian collection in the Museum. From his description and from inspection of the specimens, it would seem that they probably arose from the intracranial part of the internal carotid artery within the cavernous sinus.

Intracranial aneurysms occasionally present themselves as expanding intracranial lesions in this way, but this aspect of their natural history is not within the scope of my lecture today.

It was Symonds in 1923 who first drew attention to ruptured intracranial aneurysm as the commonest cause of spontaneous subarachnoid haemorrhage, a clinical syndrome described only a year before by Collier. From that time a vast literature grew up as the condition became increasingly recognized, and it was not long before surgical treatment, designed to prevent recurrence of bleeding from ruptured aneurysm, was being considered. In 1933 Dott reported two successful cases of operative treatment for ruptured intracranial aneurysm ; by direct exposure of the aneurysmal sac and muscle wrapping in one instance and by proximal or Hunterian ligation of the internal carotid artery in the other. Thereafter this field of work was elaborated by Tönnis, McConnell, Jefferson, Dandy and Dott, aided to a great extent by the increased use of cerebral angiography which had been discovered by Moniz in Lisbon in 1927. However, particular credit must go to Dandy who did so much to advance surgical treatment without the aid of angiography. In more recent years Falconer,

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*Based on a paper " The surgery of ruptured intracranial aneurysms " given to the Medico-Chirurgical Society of Edinburgh, 1st December, 1954.

Norlén, Olivecrona, Poppen, Hamby and many others have added to our knowledge of this fascinating field of medicine and surgery.

The frequency of ruptured aneurysm is now well recognized and its importance as a social problem cannot now be lightly disregarded, for the highest incidence lies in the age groups of thirty to fifty-five years, the contributors of our society. The gravity of the effects of aneurysmal rupture, and particularly that of recurrent bleeding, both as regards morbidity and mortality, constitutes a major challenge to the practitioner, physician and neurosurgeon alike.

The logical approach to the management of ruptured intracranial aneurysm is very dependent on a broad knowledge of the natural history and living pathology of the condition. Careful history taking, not only from the patient but also from his relatives, and the correlation of it with the results of clinical examination, cerebral angiograms, and operative findings form the basis of such knowledge.

Pathology

Aneurysmal sacs are largely confined to the circle of Willis itself, although a large group arise from the middle cerebral artery at its first primary branching (Fig. 1). When an aneurysm ruptures there is a sudden extravasation of blood from a breach in the fundus of the sac, into the subarachnoid space or brain or both, depending on the anatomical relationships of the sac and the severity of the haemorrhage. Approximately 50 per cent. rupture at some time or another into the brain substance and occasionally into the ventricular system as well (Hyland, 1950). Observations at operation would suggest that the trend of events is as follows. As the aneurysmal sac enlarges it becomes more closely apposed to overlying brain. The first relatively minor haemorrhage causes local meningeal reaction and softening of the adjacent brain substance. The sac distends further and its wall becomes progressively thinned, often patchily, with the formation of small blebs, loculi or daughter aneurysms. The sac soon ruptures again, this time with greater severity as the extravasated blood disrupts the adherent and softened brain and so forms a considerable intracerebral haematoma. This mode of behaviour is particularly true for aneurysms which arise from the anterior communicating and middle cerebral arteries as they lie in the median and Sylvian fissures. Other aneurysms, like those at the posterior communicating-carotid junction and at the termination of the basilar artery, lie free in the subarachnoid space within the basal cisterns, and therefore tend to bleed directly into the subarachnoid space. However, even then, if extravasation of blood is great, it may be forced through the basal fissures into the brain and sometimes into the cerebral ventricles. Occasionally blood is forced into the subdural space through a tear in the arachnoid, forming a subdural haematoma (Clarke, et al., 1953).

It would appear from the fresh appraisal of many case histories, that a patient's first episode of subarachnoid bleeding is commonly of minor
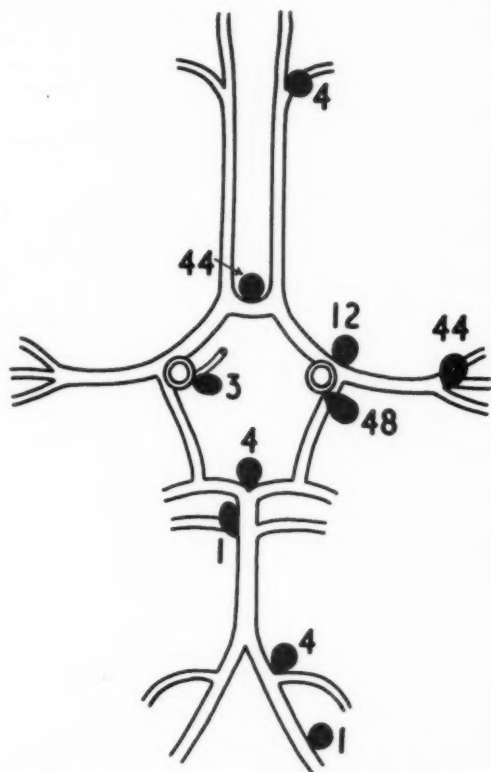
INTRACRANIAL ANEURYSMS
TOTAL—165
Feb. 1950 — Feb. 1956
DEPARTMENT OF SURGICAL NEUROLOGY,
ROYAL INFIRMARY, EDINBURGH.

Fig. 1. Diagram of the circle of Willis showing the common situation of ruptured intracranial aneurysms as shown by angiography, operative exploration or autopsy.

severity ; a mere leak of blood from the sac. There is sudden severe pain in the neck which rapidly radiates upwards over the vertex of the head. It is then followed by generalized headache which clears up in a day or two. A diagnosis of fibrositis, influenza or stiff neck may be made by the patient, his relatives or his medical attendant. Fortunately the presence
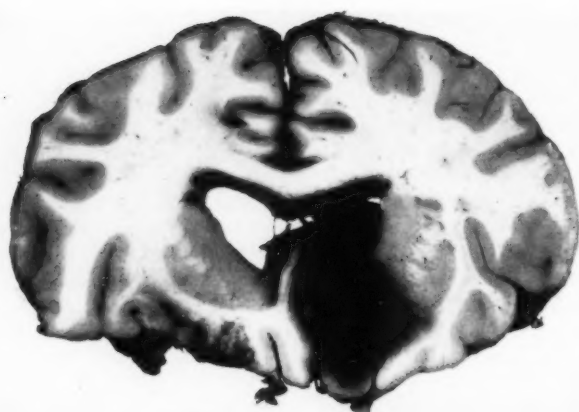
Fig. 2. Circle of Willis and coronal section of the brain showing an anterior communicating aneurysm which has ruptured upwards into the left postero-inferior frontal region, pre-optic region and into the ventricular system.

of neck stiffness, even of minor degree, and other signs of meningism, usually indicate the true diagnosis. The accurate clinical assessment of such an attack is of great importance, in view of the probability and gravity of a second haemorrhage within the next few days ; commonly between the second and the twenty-first day following the first haemorrhage. This second episode of bleeding, as we have seen, is often more severe than the first. The patient is unconscious for a period and is usually left with neurological deficits such as hemiplegia, visual field defects, language difficulties, apathy and negativism, dependent to some extent on the presence of an intracerebral haematoma. However, some patients die within minutes or hours of raised intracranial pressure from a massive intra-cerebral and intra-ventricular haemorrhage, and in a few patients this disastrous episode seems to represent the initial and only attack of bleeding, as opposed to the second or third (Figs 2 and 3).

Extravasation of blood into the basal cisterns and over the cerebral cortex within the subarachnoid space inevitably causes some obstruction of the cerebro-spinal fluid circulation, and this aspect of the living pathology is perhaps not fully appreciated. There follows a degree of distension of the ventricular system and to some extent the basal cisterns as well, for a variable period after the episode of bleeding. Indeed, at operation, during the early days after bleeding, this temporary distension of the ventricles is commonly found and can be usefully exploited. Continuous ventricular drainage during the definition of an aneurysmal sac markedly lowers intracranial tension, and allows good exposure with minimal retraction. Spinal drainage at operation produces this effect more slowly and is less easily controlled. Sometimes this early obstructive hydrocephalus may be so severe that the patient may become stuporose from this cause but is quickly relieved by recognition of the complication and the institution of spinal drainage (Dott, 1956). Later, in a few patients, within weeks of subarachnoid bleeding, there occurs an abnormal meningeal reaction to the presence of blood in the subarachnoid space. This often leads to permanent obstruction from arachnoid adhesions with the formation of a communicating hydrocephalus which demands treatment for its relief. In our experience, these patients have been successfully managed by the diversion of cerebrospinal fluid into the peritoneal cavity (Dott and Gillingham, 1958).

Another important factor besides the extravasation of blood in determining mortality and morbidity in aneurysmal rupture, is the effect of arterial spasm which appears to arise in the region of the neck of the sac at the time of rupture. Its cause is not certain for it is of variable duration and consequently elusive. Whether it arises from extravasation of blood into the arterial wall adjacent to the sac, from the tug on the parent vessel as the aneurysm ruptures (Johnson, 1954), or from the stretching of neighbouring vessels by accumulating clot outside them (Dott, 1953),
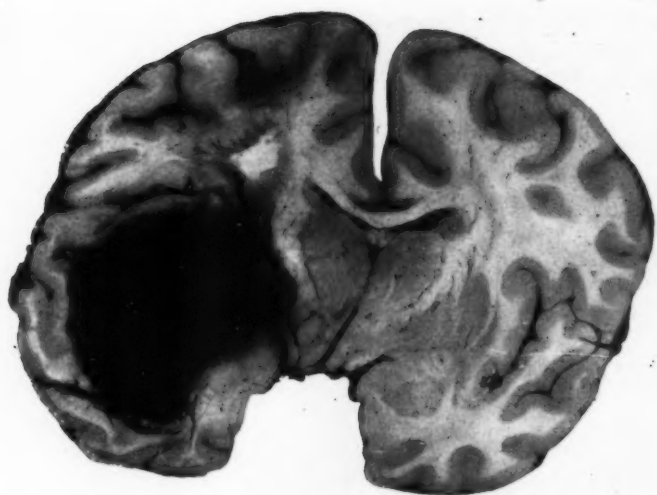
Fig. 3. Circle of Willis and coronal section of the brain showing an aneurysm of the middle cerebral artery which has ruptured downwards into the temporal lobe. Note the gross displacement of the midline cerebral structures and the herniation of the cingulate gyrus beneath the falx.

94

it is difficult to say. Certainly the degree of spasm would seem not to be related to the volume of extravasated blood outside the sac. In some patients spasm is intense and widespread, spreading proximal as well as distal to the aneurysm ; of long duration, and often quickly re-established by the irritating effects of the medium used in angiography, or by the operative manipulation of the vessel.

Case I

A woman of fifty-seven was admitted with a classical picture of spontaneous subarachnoid haemorrhage, verified by lumbar puncture. When seen six days after the episode, she was drowsy and showed a slight right hemiparesis, maximal in the face. Left carotid angiography failed to show a suspected middle cerebral aneurysm, and there was no spasm or significant displacement of vessels (Fig. 4a). She improved slowly and it was planned to repeat the left carotid angiogram in a few days. Unfortunately, four days after the first angiogram there was clinical evidence of further bleeding with a sudden depression in her level of consciousness, an increase of the right hemiparesis, and an increase of neck stiffness. Angiography carried out immediately showed a gross degree of spasm of the left middle cerebral artery, and a definite aneurysmal sac at the first primary branching. Spasm was most marked at the neck of the sac and extended widely into the peripheral branches and into the left anterior cerebral artery. Following angiography this patient deteriorated further. She became comatose and died six days later as a result of raised intracranial pressure from ischaemic swelling of the left cerebral hemisphere which arose from infarction following thrombosis of the fronto-temporal branch of the left middle cerebral artery (Fig. 4b, c and d). Autopsy showed only a minor extravasation of recent blood in the Sylvian fissure in the neighbourhood of the sac and no evidence of discolouration or frank blood elsewhere.

This patient illustrates the existence of spasm and of its probable relationship to rupture of an aneurysm with a minimal leakage of blood. It is possible that angiography further aggravated the spasm which ultimately precipitated the thrombosis of the vessel in the neighbourhood of the sac.

Case II

A young woman of thirty-three suffered a sudden attack of spontaneous subarachnoid haemorrhage, from which she showed apathy and slight drowsiness, but no neurological deficits. Bilateral carotid angiography showed a tiny aneurysm of the anterior communicating artery, associated with a gross degree of spasm of both anterior cerebral arteries in their basal and distal parts, more marked on the right side. Following angiography, which had probably greatly increased the spasm, she remained deeply comatose for several days and akinetic and mute for several months, slowly recovering but with considerable defects of initiative and perseverance. No surgical treatment was undertaken (Fig. 5a and b).

Case III

A nursing sister of thirty-nine was operated upon a few days following a relatively minor attack of spontaneous subarachnoid haemorrhage, an aneurysm of the right middle cerebral artery being demonstrated by angiography. Moderate spasm of the middle cerebral artery which extended into the anterior cerebral and internal carotid arteries, and into the peripheral branches of the middle cerebral artery was present. This spasm was demonstrated at operation three days after angiography but it was not severe. Just as a blunt hook was passed

95

Fig. 4(*a*).   Left carotid angiogram—apparently within normal limits.

Fig. 4(*b*).   Repeated left carotid angiogram four days later showing a severe degree of spasm of the left middle cerebral artery. maximal at the neck of an aneurysmal sac which arises at the first primary branching.   Spasm also extends for some distance into the left anterior cerebral artery.
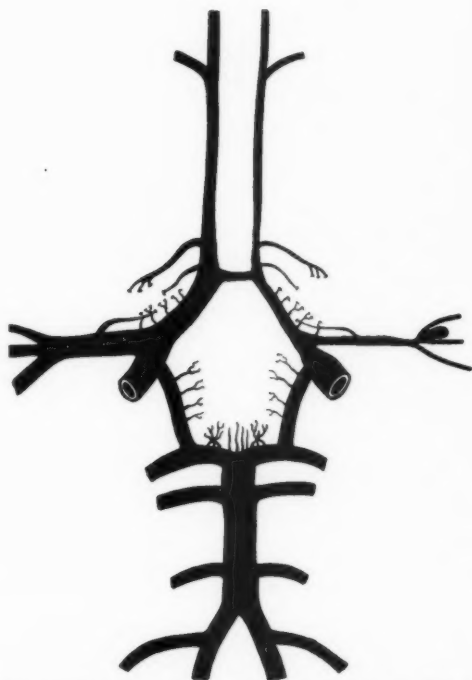
96

Fig. 4(c). Diagrammatic representation of the site of the sac and the associated spasm. Note the striate branches of the middle and anterior cerebral arteries which pass through the anterior perforated substance and which are involved in the spasm.
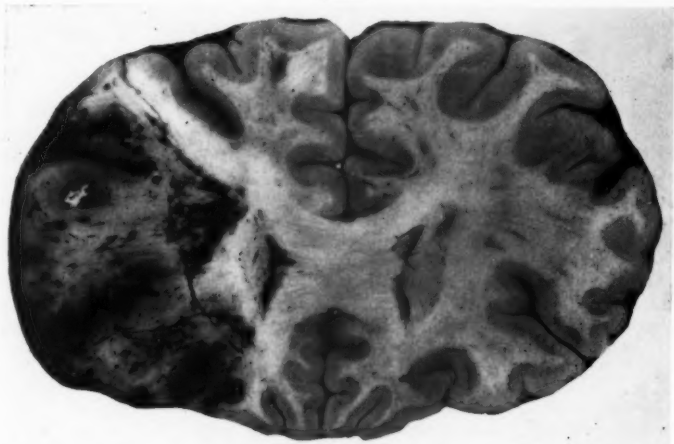
Fig. 4(d). Coronal section of the brain to show infarction of part of the territory of supply of the middle cerebral artery.

97

round the neck of the sac prior to placing a clip across it, the whole middle cerebral trunk and its peripheral branches were involved in a sudden intensification of the spasm, the vessels taking on the appearance of a white thread, and the aneurysm becoming much smaller. The prolonged application of 2·5 per cent. papaverine on linteen swabs to the vessel relieved spasm by approximately 25 per cent., and finally a silver clip was placed across the neck of the sac. Postoperatively this patient was slow to recover. She was comatose and hemiparetic for a few days and then apathetic, although ultimately she returned to part-time nursing, which she managed reasonably well. There was no recurrence of bleeding during a subsequent follow-up period of four years.

This is only one example of several instances of spasm occurring during manipulation of a vessel in the neighbourhood of aneurysmal sac, but since the use of prophylactic locally-applied papaverine to the vessels as soon as they were exposed it has not been seen.

Cerebral arterial spasm associated with aneurysmal rupture is not always widespread and intense, but often minimal and short-lived. In many patients one suspects an individual constitutional factor as a basis for the production of spasm. Its effect would seem to be that of protection —the aneurysm is greatly reduced in size and ceases to bleed, but if spasm is sustained, intense and widespread, it can be fatal or lead to permanent emotional, intellectual and neurological change of considerable severity. In this respect the situation of the midline anterior communicating aneurysm in relationship to the proximal anterior cerebral arteries of both sides, and their striate branches, is particularly vulnerable (Watson and Gillingham, 1953). These branches are concerned with the blood supply of the anterior part of the diencephalon and adjacent structures, areas of the brain concerned with the maintenance of consciousness and autonomic functions (Figs. 4 and 5). This is indeed borne out, as you will see, by the particular difficulties which arise in the management of the anterior communicating aneurysms and in the mortality and morbidity associated with this particular group of patients.

Case IV

A woman of forty-eight was left apathetic and in a Korsakow state following rupture of an anterior communicating aneurysm. Some six weeks after the episode she showed little improvement, and she remained facile and disorientated but without neurological deficit. Clipping of the neck of the sac was performed by the sub-frontal route to prevent a recurrence of bleeding. Operation was uneventful, and presented no difficulty. Postoperatively she was unchanged, but gradually over the next few weeks she slowly deteriorated, showing increased apathy and wasting, and she ultimately died. Autopsy showed no intra-cerebral or subarachnoid clot, and no macroscopic lesion. Satisfactory clipping of the neck of the sac was found to have been achieved without involvement of major or minor vessels. Histological sections of many parts of the brain, including the cerebral cortex, showed no significant abnormality, but there were definite ischaemic changes present in the head of the caudate nucleus and the pre-optic areas of both sides, the territory of supply of the striate or perforating branches of the anterior cerebral artery in its basal part. The absence of clot or macroscopic disruption of the pre-optic area suggested that her clinical state resulted from prolonged spasm of the basal anterior cerebral arteries at the time of aneurysmal rupture with ischaemia of their territories of supply.

Occasionally spasm involves the distal as well as the basal parts of the anterior cerebral arteries with ischaemia of the corresponding territories of supply and resultant paraparesis of greater or less severity and duration which complicates the picture of spontaneous subarachnoid haemorrhage.

Recurrence of bleeding from an aneurysm is no doubt partly determined by the relaxation of this spasm and partly by imperfect healing of the sac by thrombosis, the greatest danger of such bleeding being between the seventh and fourteenth day after the first. So far we have found no reliable systemic antispasmodic and perhaps it is just as well for the mortality of recurrent bleeding within a few weeks of the first is in the region of 30 per cent. (Walton, 1956). However, we have found at operation that the local application of a 2.5 per cent. solution of papaverine by means of small linteen swabs to the vessel wall is an excellent prophylactic against the re-establishment of spasm during manipulation and does help to relax moderate spasm after application for ten minutes. Severe and widespread spasm does not seem, however, to respond even after prolonged application of up to forty-five minutes (Kinmonth, 1952). Sympathetic blocks in the neck or stellate ganglion block do not appear to relieve this type of spasm. Its relief by local application suggests a myogenic origin. A possible disadvantage of the use of locally applied papaverine is recurrence of spasm after its effect has worn off. We have suspected that such an event has occasionally occurred and in one patient a tiny polythene tube was placed within the Sylvian fissure close to the middle cerebral artery for the daily instillation of the drug. The value of this procedure was indefinite, for the pre-existing hemiparesis was unchanged. Lende of Montreal (1955) has demonstrated this type of recurrent spasm of the cerebral arteries which was initiated in his experiments by the trauma of manipulation. His results suggested that Rogitine was preferable to papaverine for the prolonged relief of spasm.

Diagnosis

The diagnosis of spontaneous subarachnoid haemorrhage is by careful clinical assessment and it is confirmed by lumbar puncture. Diffusely blood-stained fluid is obtained with xanthochromic discolouration of the supernatant fluid on centrifuging. There is a danger of confusing the diagnosis by clumsy procedure, blood from traumatised vessels being spilled into the C.S.F. A minor episode may thus be ignored with the possibility of a fatal issue from a further bleeding from ruptured aneurysm in a few days. This investigation should therefore be performed by skilled staff and preferably in hospital.

Ruptured aneurysm as a cause of spontaneous intracranial haemorrhage is the most likely diagnosis in the younger age groups. The catastrophic nature of the episode particularly in association with preceding and often unilateral headache, unconsciousness, meningism and neurological deficits adds confirmation. Other relatively common causes of subarachnoid

(i)

(ii)

Fig. 5(a). (i) A.P. and (ii) lateral left carotid angiogram showing a gross degree of spasm of the left carotid artery and its branches, maximal at the basal part of the left anterior cerebral artery. A small aneurysm of the anterior communicating artery is poorly outlined.

100
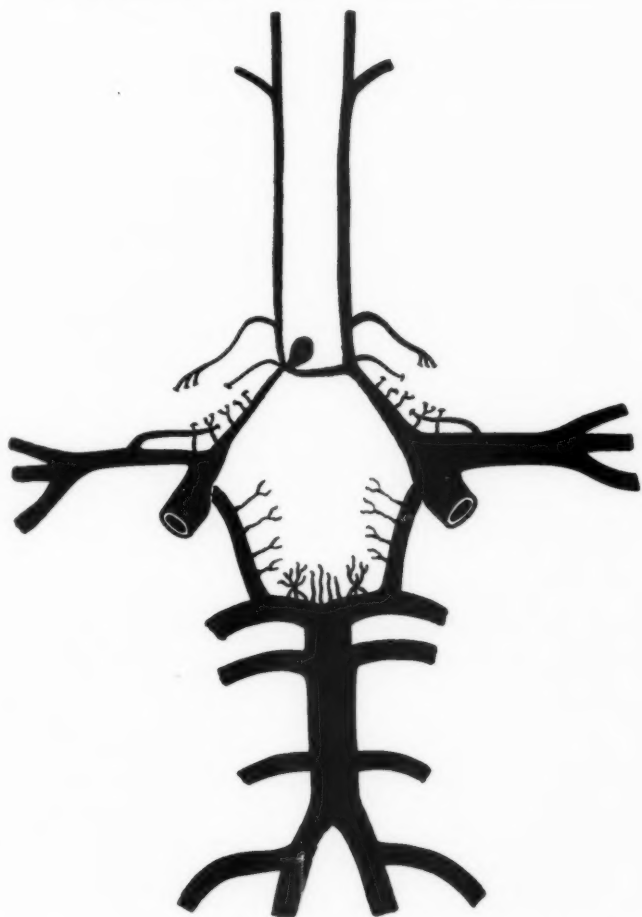
Fig. 5(*b*). Diagrammatic representation of the spasm and how it may extend bilaterally as well as into the ipsilateral middle cerebral and internal carotid arteries. Note how the striate branches of the anterior cerebral arteries are involved by the spasm on both sides.

haemorrhage are bleeding from an arteriovenous malformation and unsuspected intracranial tumour (Gillingham, 1952).

Plain X-ray of the skull is usually unhelpful. Aneurysmal sacs which calcify seldom rupture. The presence of enlarged diploic or meningeal channels are suggestive of arteriovenous malformation.

101

Confirmatory diagnosis of intracranial aneurysm is entirely dependent on cerebral angiography. This method of investigation was first developed by Moniz in Lisbon in 1925, and in Great Britain in 1929 by Dott and Jefferson. Rapid advances in percutaneous techniques followed in Scandinavia after the war, but mainly in the field of carotid angiography. Outlining of the vertebral system of vessels was less certain until the lateral percutaneous method was developed by Maslowski in Edinburgh in 1951 (Maslowski, 1955) (Fig. 6). Stereoscopy in addition has made angiography accurate for the precise definition of aneurysmal lesions and their connections.

Between March 1950 and December 1954, 228 patients were investigated for spontaneous intracranial haemorrhage, the majority of whom had bilateral carotid and vertebral angiograms if no lesion was found at first. Of these 120 were found to have intracranial aneurysms, twenty-five had arteriovenous malformations, and four had unsuspected tumours.

In spite of rapid progress in the development of angiography there is reason to believe that further advances are necessary in radiographic techniques, particularly in the outlining of the anterior communicating region. Of the 120 patients with aneurysms, five showed no lesion in their first angiograms. Each bled again within a few days or a few weeks. Four died of rupture of anterior communicating aneurysms, and one of rupture of a middle cerebral aneurysm. An aneurysm may not fill because of spasm or because of clot in the sac which later becomes excavated. When spasm is present and no sac apparent we have learned to repeat the investigation within a few days when the patient's clinical condition has improved, for often as spasm decreases the aneurysm can be demonstrated. Oblique films have shown an otherwise obscure sac in routine A.P. and lateral views.

Of these 228 patients, seventy-four (32.5 per cent.) with spontaneous intracranial haemorrhage failed to show any abnormality with careful angiographic studies. Whether they had minute aneurysms that were not outlined or whether thrombosis had occurred within the sac it is difficult to say. Nevertheless the prognosis in this group would seem to be very favourable. However, the number of negative angiograms has become somewhat less as investigation has been undertaken earlier and with greater accuracy.

In general, angiography does not aggravate the condition of the patient except where spasm has been severe and in these cases it has to be used with caution. Dangers lie in re-establishing spasm by the irritant effect of the dye, and in the production of marked vascular hypotension, as anaesthesia is induced (general anaesthesia was used in all cases). Severe and prolonged hypotension adds to the already existing ischaemic lesions of the diencephalon or other territories of supply of the involved vessels (Brown, 1955). Urographin 50 per cent. would appear to be more satisfactory than Uridone in this respect and at the same time provides improved definition (Donaldson, 1957).

If spasm is marked on the first film the procedure is abandoned until the clinical condition of the patient improves to suggest relaxation of spasm. A further cautious angiogram is then done and if spasm is no longer present, an attempt at full definition of the sac is undertaken.

Fig. 6. Percutaneous vertebral angiography by the lateral route (Maslowski) showing a large bilocular aneurysm at the termination of the basilar artery which was approached by a right sub-temporal route. The aneurysm was wrapped in fascia.

Treatment

From pathological features we have considered, the logical approach to the problem of aneurysmal rupture is to prevent recurrent bleeding as soon as possible after the aneurysm has been localized and its connections defined by angiography ; if possible within the first week of bleeding. Nevertheless, experience has shown that the earliest intervention presents difficulties and dangers.

Direct exposure of the aneurysmal sac with a view to occlusion of its neck is the ideal surgical treatment, but there are certain hazards. Friable swollen brain which follows recurrent and severe episodes of bleeding from the sac tends to make the approach to the aneurysm traumatising. The sac itself, whilst being freed, may rupture with the attendant dangers

of an obscured operative field, accidental occlusion of important vessels, spasm, and severe reduction of blood flow to the territory of supply of the artery involved. Severe and prolonged bleeding from the aneurysm may further exsanguinate these territories of supply. Existing ischaemic lesions are very likely therefore to be accentuated and especially if planned hypotension and prolonged retraction are used. Fortunately these difficulties present a major problem only in the midline anterior communicating aneurysm which is situated so deeply beneath the frontal lobes above the sella turcica. Prolonged retraction of the frontal lobe necessarily causes traction on the important perforating striate branches of the anterior and middle cerebral arteries with the danger of spasm and further reduction of their blood flow (Figs. 5 and 6). Temporary contralateral hemiparesis and a slow return of consciousness over some hours in these patients after operation is probably dependent on this factor. Indeed, we have had the opportunity to demonstrate this complication of deep frontal lobe retraction in the open operation of coagulation of the Globus Pallidus for Parkinsonism (Guiot and Brion, 1953). The procedure is ideally carried out under local anaesthesia and as the anterior perforated substance is approached these striate vessels are seen to elongate as the frontal lobe is retracted upwards and backwards. Occasionally frank spasm of the anterior and middle cerebral arteries or their striate branches is seen, which can usually be promptly relieved with locally applied papaverine. There is coincidental raising of the systolic blood pressure and increase of the pulse pressure, lowering of the conscious level of the patient to light stupor and the appearance of a contralateral hemiparesis. The severity and continuance of these changes depends on the duration and extent of retraction. Withdrawal of the retractor almost completely reverses the changes produced within several minutes but they recur with further retraction irrespective of the site of compression by the tip of the retractor (Fig. 7).

The temptation to delay operative treatment until ideal conditions prevail, that is between four to eight weeks after bleeding, when spasm and its effects—hyperaemia and raised intracranial tension have subsided is, of course, great. A low mortality and morbidity can be achieved with operation at such a time (8 per cent. mortality in this series). However, many authors (Walton, 1956) have shown that the mortality of patients with ruptured aneurysms treated expectantly within the first eight weeks of their illness is in the region of 50 per cent., and that a further 20 per cent. will die during the following months or years from a further haemorrhage. About 15 per cent. (Walton, 1956) die within the first twenty-four hours of an initial overwhelming episode and it would seem unlikely that the surgeon will be able to help such patients. However, this figure may not represent the true estimation of the mortality attending the first haemorrhage. We have become increasingly aware of the significance of the first minor attack of subarachnoid bleeding which is so

often missed and only brought out with careful questioning of the patient and his relatives (Gillingham, 1954 ; Symonds, 1956). The second and sometimes severe episode is therefore often regarded as the first. Following such a minor incident—a mere leak of blood into the subarachnoid space —the patient is relatively undisturbed, and operating conditions within a few days of it are nearly ideal. Intracranial pressure is almost normal. The brain is often slack and free from hyperaemia, whilst the walls of the aneurysmal sac are still relatively strong and will tolerate manipulation
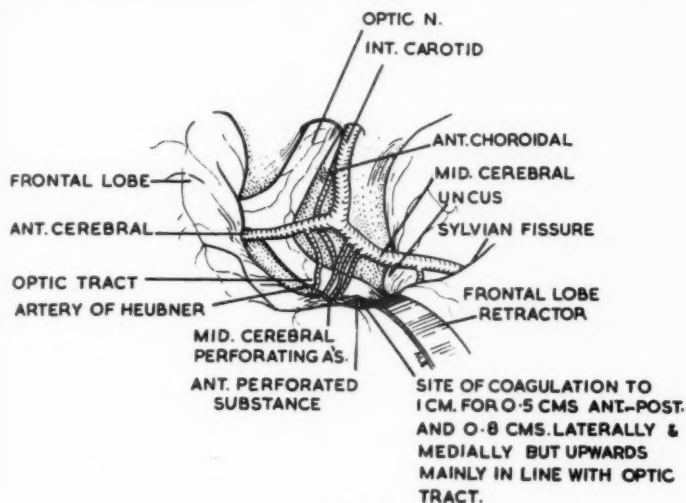
Fig. 7.

more easily. Mortality and morbidity from operative treatment in this group is low, whilst morbidity and mortality from operative treatment in patients with severe neurological deficits and a reduced level of consciousness is high. Another important factor in the true understanding of our problem is that morbidity and mortality of ruptured aneurysm is closely related to their situation on the circle of Willis and its branches.

Aneurysms of the anterior communicating artery

The anterior communicating aneurysm lies beneath the pre-optic region of the hypothalamus and in the midst of its blood supply. The combined effects of extravasation of blood into this area and ischaemia from spasm of the proximal parts of the anterior cerebral arteries and their branches which sometimes accompanies rupture of the sac, leads to disturbance of consciousness, apathy, disorientation, negativism and occasionally catatonia (Figs. 2 and 5). Severe lesions give rise to profound metabolic changes, wasting, stupor, finally coma and death.

Less severe lesions give rise to a state aptly described by Cairns (1941) as akinetic mutism. A direct operative approach in the early days after bleeding with a view to occlusion of the neck of the sac accentuates these lesions and we have therefore abandoned it in stuporose patients. Dott (1953) has advanced the theory that tension within an aneurysmal sac is maintained and its rupture often determined by the force of the arterial jet from the major arterial trunk upon its fundus. Angiographic studies show that aneurysms of the anterior communicating artery are often filled from one anterior cerebral artery and not the other. With the demonstration of an adequate cross-circulation through the anterior communicating artery, clip-occlusion of the appropriate anterior cerebral artery may therefore be carried out as a means of reducing the force of the arterial jet upon the sac. This method of treatment was first satisfactorily explored in 1944 by Dott, and this patient remains alive and well. Our more recent experiences have been equally favourable and coincide with those of Logue and McKissock (1956). This indeed would seem to be the method of choice at present for the early treatment of the anterior communicating aneurysm. The application of the clip to the anterior cerebral artery in most cases requires little retraction, but the site of application is a matter for care in order to avoid damage to the striate branches of the anterior cerebral artery. Placing the clip close to the aneurysm leaves these important arteries to be fed from the ipsilateral carotid artery, but in so doing the sac may be dislodged and rupture. If the cross-circulation is seen to be adequate on the angiogram it may be wiser to place the clip close to the bifurcation of the carotid artery. This aspect of the problem is under investigation at present (Fig. 8).

The type of clip used is important. I have the experience of a firmly closed Cushing type of silver clip being progressively dislodged after an interval of a month with fatal haemorrhage from the aneurysm because of the lack of corrugation on its inner surfaces. I have also watched three such silver clips placed separately across the body of a sac on the middle cerebral artery move in slow procession with each pulsation towards its fundus. The Olivecrona or similar pattern of clip grips more satisfactorily, being larger, flatter, and corrugated on its inner aspect. Some few patients unfortunately have an inadequate cross-circulation and in these clip-occlusion or ligation of the neck of the sac is the only adequate method of treatment.

As will be seen from the analysis of cases (Fig. 9), twenty-one of the eighty patients treated had anterior communicating aneurysms, many of these arising from the junction of one anterior cerebral artery and the anterior communicating artery. In some, the anterior communicating artery was no more than a " cross-roads " between one anterior cerebral artery and the other, the aneurysm arising at that point. None arose from the basal

OPERATIVE TREATMENT

Fig. 8. Diagram of operative treatment of intracranial aneurysms. The clip on the internal carotid artery is purely diagrammatic, representing proximal ligation of the common carotid artery in the neck. Note the broad complex neck which complicates most middle cerebral aneurysms.

part of the anterior cerebral artery itself. Many of this group were operated upon in 1951 and 1952, when methods of treatment were being explored, usually within a day or two of bleeding, without selection and

usually by clip-occlusion of the neck of the sac using an inter-frontal or sub-frontal approach. At that time our comprehension of the living pathology of aneurysmal rupture was still immature. Most of the patients were in coma or stupor before operation. Mortality in this group was very high, but it is from our experience of these patients that we owe the evolution of a greater understanding of the problem. From 1953 this type of aneurysm was treated by clip-occlusion of the appropriate anterior cerebral artery, provided an adequate cross-circulation was demonstrated, with a remarkable lowering of mortality and morbidity. Operation carried out later than three weeks after bleeding resulted in a greatly reduced mortality. In this group of nine patients there were no

OPERATIVE TREATMENT OF RUPTURED INTRACRANIAL ANEURYSMS—TOTAL 80

Site of aneurysm	No. of cases	Cases treated in first three weeks	Alive and well	Severely dis-abled	Dead	Cases treated after three weeks	Alive and well	Severely dis-abled	Dead
*Carotid/ Post. Comm. Antr. Choroidal	18	15	12	2	1	3	2	1	0
Middle Cerebral	26	18	10	7	1	8	4	4	0
Intracnl. Carotid Bifurc.	7	4	1	2	1	3	3	0	0
Anterior Communic.	21	12	4	0	8	9	6	1	2
Anterior Cerebral	3	3	2	0	1	0	0	0	0
Vertebral-Basilar	5	3	0	0	3	2	1	1	0
TOTAL	80	55	29	11	15	25	16	7	2

* Two patients with aneurysms at the carotid/ophthalmic junction included.
Forty-five patients returned to their previous occupations (five slightly disabled).
Follow-up—Ten months to six years. Sixteen of sixty-three alive failed to report progress.

Fig. 9. Analysis of a consecutive series of eighty patients treated between February 1950 and February 1956.

immediate postoperative deaths. The two patients who died subsequently did so because of recurrent bleeding from the aneurysmal sac; in both, proximal occlusion of the appropriate anterior cerebral artery had been performed. In one case, death occurred one month after operation from displacement of the Cushing clip from the artery; in the other, death occurred two years after operation following a sudden attack of un-

108

consciousness, which was probably related to a recurrent haemorrhage. Unfortunately the patient was not seen and no autopsy was obtained to confirm this supposition. Nevertheless, in our experience, adequate clip-occlusion of the anterior cerebral artery would appear to be the most satisfactory method of treatment of the anterior communicating aneurysm in the early days after bleeding, in the absence of coma and when an adequate cross-circulation has been demonstrated.

Before leaving this important group of aneurysms it is, perhaps, important to observe that recovery from severe central basal lesions of the brain is more probable than was originally believed, provided that the initial hazards of coma, such as impaired airway, are overcome. In this and other respects these lesions are similar to those associated with severe closed head injury (Gillingham, 1952).

Aneurysms of the anterior cerebral artery

These sacs lie at the junction of the pericallosal and supramarginal branches of the anterior cerebral artery at the genu of the corpus callosum and are best approached along the medial aspect of the frontal lobe. Ligation or clip-occlusion of the neck of the sac is the method of treatment, and should be carried out as soon as possible after the first episode of bleeding, taking care to avoid kinking of the peripheral vessels. The otherwise excellent outlook for these patients is occasionally prejudiced by extravasation of blood downwards and backwards in the coronal plane, carrying out what is in fact a more or less posteriorly-placed leucotomy with all the untoward effects of it, namely, stupor, apathy, negativism, or in some cases coma and death (Meyer, 1954). The clinical picture is similar to that of rupture of an anterior communicating aneurysm.

All three cases in this series were treated early. Two are alive and well. One died a week after operation with deepening of preoperative coma, but this patient might have been saved by delaying operation until her level of consciousness had risen even at the risk of a recurrent haemorrhage from the sac. Autopsy showed no significant volume of intracerebral clot, but there was a good deal of destruction of the pre-optic area and the post-frontal region.

Aneurysms of the middle cerebral artery

The common site of origin of these aneurysms is at the first primary branching in the lateral half of the Sylvian fissure. The fundus of the sac is often adherent to the superior aspect of the temporal lobe but occasionally to the inferior aspect of the frontal lobe. Intracerebral clot is a frequent complication of rupture, but it is found more commonly within the temporal lobe than in the frontal lobe. Gentle evacuation of blood from the clot cavity by aspiration before opening the Sylvian fissure will give added access following reduction of intracranial tension

by ventricular drainage. Clot within the Sylvian fissure is often a g.... to the aneurysmal sac, but it is a wise precaution to define the ..... trunk of the middle cerebral artery at the medial end of the Sylvian fissur. before exposure of the sac is attempted. The early application of lo... papaverine to the exposed vessels is an essential step at an early stage to prevent accentuation or re-establishment of spasm. Every care must be taken to avoid dislodgement of the adherent fundus of the sac to prevent rupture. Minor bleeding can usually be controlled by the strategic application of a tiny piece of muscle. As soon as the neck and proximal half of the sac are displayed, a large, flat type of clip of the Olivecrona pattern is placed across the middle of the sac to prevent bleeding as the fundus is dislodged, and the sac and its connections are dissected free. Should major bleeding occur, temporary occlusion of the ipsilateral carotid artery in the neck by finger pressure is carried out by the anaesthetist. Reduction of bleeding then allows definition of the bleeding point by means of skilled suction. Proximal occlusion of the middle cerebral artery is probably unwise in view of the danger of injury to the striate branches of the middle cerebral artery or the intima of the main trunk of the vessel.

Usually the neck of the sac is broad and implicates one or two of the peripheral branches. Ligation or clipping of it often causes constriction of the peripheral branches and may lead to postoperative neurological, emotional or intellectual deficits from ischaemia due to kinking or thrombosis, and this practice has now been abandoned since 1954. Wrapping of the whole sac in sterile muslin gauze and then by a layer of temporal fascia surrounds it with a dense covering of fibrous tissue within a few weeks. The use of this method over the past three years has been entirely satisfactory with minimal postoperative deficit and no recurrence of bleeding. As will be seen from the analysis of cases, only one death occurred in this group of twenty-six patients, eighteen of whom were treated within twenty-one days of bleeding. This fatality was due to recurrent bleeding from a breach in an arteriosclerotic plaque on the middle cerebral artery, the site of the original haemorrhage. An aneurysm of the primary branching lateral to it appeared to be entirely intact and had apparently never ruptured.

In contrast to the group of anterior communicating aneurysms mortality in this group of cases is seen to be very low but morbidity relatively high (Fig. 9). Those severely disabled achieved their limb, visual and occasional language deficits, in the main, preoperatively from major recurrent haemorrhage. Two sustained permanent deficits from persistent spasm, which was induced by manipulation of the neck of the sac at operation, in the days before prophylactic locally-applied papaverine was used. This complication has not been observed since. Four others showed marked deficits following ligation or clipping of the

110

of the sac with kinking or occlusion of one or more of the peripheral
branches of the middle cerebral artery.

Aneurysms of the intracranial carotid artery

This group, which includes aneurysms at the carotid bifurcation and
at the junction of the posterior communicating and anterior choroidal
arteries with the carotid artery, lends itself to two types of operative
treatment. A detailed account of these aneurysms and their management
in Edinburgh has been published elsewhere (Harris, *et al*, 1957). Proximal
ligation of the ipsilateral common and internal carotid arteries in the
neck in two stages, is the method of choice, provided that the cross-
circulation has proved to be adequate by angiography and by carotid
compression tests at the time of operation under local anaesthesia.
However, it may well be that common carotid artery ligation is sufficient
in many of these cases. In the absence of an adequate cross-circulation,
gradual progressive occlusion of the common carotid artery in the neck
over several hours or days, using the Dott occlusion clamp, may be
achieved with success. Direct approach to aneurysms of the carotid
bifurcation in the early days after bleeding, is extremely hazardous and
proximal occlusion is much preferable to a direct approach. However,
those aneurysms lying at the junction of the posterior communicating or
anterior choroidal arteries with the internal carotid artery are less of a
problem when a direct approach is required, and are best approached
beneath the temporal lobe, through a vertical scalp incision and a
relatively small bony decompression. The internal carotid artery is
seen to pass directly upwards towards its bifurcation at the edge of the
tentorium once the arachnoid is opened. The neck of the sac and the sac
itself passes directly backwards and clip application is rendered easy
providing retraction is gentle and the aneurysm is not ruptured at an
early stage.

The effect of the sacrifice of one major artery to the brain of an ageing
circulation has yet to be determined, but proximal ligation has much
to offer. It removes many of the hazards of an intracranial operation.
Major neurological deficits arising within the first forty-eight hours of
carotid ligation are often dependent upon a hypotensive episode,
but these are usually of a transient character if treatment is quickly
directed towards the raising of the intracranial blood pressure. Ligation
in two stages, first of the common carotid artery, and after a few weeks,
of the internal carotid artery, lessens this risk. Hemiparesis or hemi-
plegia occurring towards the end of the first week is probably the result
of a spreading thrombosis to the bifurcation of the internal carotid
artery, with obstruction of the middle cerebral trunk. Fortunately,
his event does not appear to be unduly common. The major contra-
indication to carotid ligation in aneurysmal rupture is coma (Schorstein,
1940) as it is indeed to any type of operation for ruptured aneurysm. As
a result of carotid occlusion some degree of cerebral ischaemia is always

111

9

added and the patient's condition deteriorates further. Expectant treat-ment is therefore the wise course to adopt, planned operation being carried out when the condition of the patient has improved sufficiently. Early operation may be necessary if clinical evidence and rising cranial pressure indicates the presence of an expanding clot, hydrocephalus or ischaemic swelling, and should be perhaps confined at that stage to the relief of intracranial pressure by decompression, ventricular or lumbar drainage or by evacuation of clot, leaving treatment of the aneurysm itself to a time when the patient's level of consciousness has improved to a satisfactory level.

Twenty-five patients with aneurysms of the carotid artery, have been treated in this series. Eighteen are alive, well and working, five are severely disabled, and two are dead. Of the five disabled patients, one showed considerable deficits from the original haemorrhage, and four developed deficits from operation complications, two from rupture of the aneurysm during operation, and two from occlusion of the carotid vessels in the neck, presumably from spreading thrombosis. One death occurred from rupture of a huge aneurysm at the junction of the carotid artery and its ophthalmic branch towards the end of continuous carotid occlusion over several days. Autopsy showed that the vessel had been virtually occluded completely, and it was felt that a possible explanation as to the cause of rupture following almost complete occlusion of the proximal artery, was that the aneurysm had shrunk down, pulling away from the overlying and supporting brain, thus tearing the friable parts of the wall of the sac. The other death occurred as a result of cerebral swelling from infarction after a difficult operative approach for an aneurysm of the bifurcation of the internal carotid artery.

Aneurysms of the vertebral-basilar system

The problem of operative treatment of these deeply-placed midline aneurysms of the basilar artery lies in their situation, at or below the level of the tentorium. Adequate occlusion of the neck of the sac because of impaired access is extremely difficult. Aneurysms at the termination of the basilar artery are particularly difficult to approach. Adequate access is achieved by means of subtemporal route, following the posterior cerebral artery medially to its junction with the posterior communicating artery. The posterior communicating artery is then divided between silver clips at this junction, and gently pushed aside. The posterior cerebral artery is followed further, medially and posteriorly. Soon another obstruction is encountered, namely, the leash of perforating vessels arising from the posterior cerebral artery, which passes upwards, and often lies between the operator and the aneurysmal sac. Wrapping of the sac with fascia was carried out in two cases, and clipping of the neck of the sac in two others. There was one early fatality (Fig. 9) and in this patient preoperative stupor was severe. The other fatality

occurred two years after operation from further rupture of the aneurysmal sac, the fascial wrapping having not been achieved adequately to cover the upper part of the fundus. During the two years of this patient's life he had been extremely well and had resumed his old occupation for most of the time.

Aneurysms of the vertebral-posterior inferior cerebellar junction would seem to be readily amenable to treatment, but the only one in this series presented at autopsy—the cause of the bleeding was thought to have occurred from a demonstrated carotid-posterior communicating aneurysm which had, however, remained intact, but which was treated by carotid ligation. Further fatal bleeding occurred from the unsuspected vertebral aneurysm several days following treatment for the other sac.

Multiple aneurysms

Dandy (1944) estimated that multiple aneurysms occurred in 15 per cent. of all cases. In our series from 1950 to 1954, it was 8 per cent., but it should be pointed out that if an aneurysm was found at a site which supported the clinical picture, no further angiography was performed. It may well be that the whole cerebral vascular tree should be outlined in each case, for we have the recent experience of bleeding from the second of two aneurysms within a few weeks of adequate treatment of the first. The problem is one of judgment, weighing up the hazards of angiography against the possible incidence of bleeding from an unknown aneurysm elsewhere. Sometimes it is extremely difficult to decide from the clinical picture which of two demonstrated aneurysms has bled. Electroencephalography sometimes helps to localise the site of bleeding. The presence of spasm and particularly of localised spasm on the angiograms is strongly suggestive of the site of aneurysmal rupture. The value of this sign has been confirmed operatively on several occasions. If there is still doubt, the operative approach can sometimes be designed to inspect the two sites. The presence of soft yellow clot in the neighbourhood of a sac strongly indicates that it has been the source of haemorrhage.

DISCUSSION

From these experiences and those of others it is apparent that the management of spontaneous subarachnoid haemorrhage from ruptured aneurysm is dependent on close liaison between the general practitioner, physician and neurosurgeon. The earliest diagnosis and reference of a patient to the neurosurgeon after the first, and usually minor, episode of bleeding, is eminently desirable. Indeed it is a matter of great urgency in the face of the high mortality and morbidity which accompany expectant treatment. Over 30 per cent. die of recurrent bleeding after the first twenty-four hours, and an additional 20 per cent. after the first three weeks have elapsed. When the patient is little disturbed by the attack,

113

the morbidity and mortality of operative treatment is correspondingly low. Mortality is especially high in the anterior communicating and basilar aneurysms, but the use of clip-occlusion of the proximal part of the appropriate anterior cerebral artery, as opposed to clip-occlusion of the neck of the aneurysmal sac has greatly reduced mortality in the group of anterior communicating aneurysms. Basilar aneurysms still present a problem largely because of difficulties of access.

The overall mortality for this personal series of eighty patients, treated between February 1950 and February 1956, is 21.25 per cent. For the twenty-five patients treated after three weeks bleeding, it is 8 per cent. Operative mortality for the fifty-five patients from all groups treated in the first three weeks bleeding is 27.3 per cent. During the first two and a half years of this period of study, no selection was made of patients for operation, and several were operated on whilst in coma, often as an emergency, after their second or third haemorrhage.

This overall figure of operative mortality of 21.25 per cent. in eighty cases of ruptured aneurysm compares favourably with approximately 50 per cent. which accompanies expectant treatment, and it can be lessened considerably by the earlier reference of patients and early operative treatment following the first episode of bleeding, by better judgment in the timing of angiography and operation, and by the type of operative procedure used.

When patients are admitted in coma or stupor it would seem wiser to delay angiography and operation until their level of consciousness improves to the state of being roused easily, in spite of the risk of further bleeding. If, in these patients, there is, however, evidence of an expanding clot, brain swelling, or communicating hydrocephalus, as shown by rising intracranial pressure, then operative treatment is indicated for the early relief of the condition.

Hypothermia (Botterell et al, 1956) was not used during operation for any of these patients. Controlled hypotension was used in a few, in the earlier cases by arteriotomy (Gardner, 1946) and more latterly by Arfonad. If we exclude the group of vertebral-basilar aneurysms, the operative mortality for the other seventy-five cases is 18.7 per cent. If we exclude the group of anterior communicating aneurysms as well, the operative mortality for the remaining fifty-four patients is 7.4 per cent. and hypothermia would seem unlikely to help the further lowering of this figure. It may be that hypothermia will be of special value in the management of the anterior communicating aneurysm, but a prolonged trial and follow-up of clip-occlusion of the appropriate anterior cerebral artery would appear to be profitable.

Since this lecture was given the opportunity has arisen for the further detailed analysis of forty-seven patients with spontaneous subarachnoid haemorrhage who were admitted for investigation from February 1956 to February 1958.

114

In fifteen, no cause for the haemorrhage was found after careful scrutiny of bilateral carotid and unilateral vertebral angiograms. Fourteen remain well and without significant morbidity but one is recovering from a residual hemiparesis which followed the episode of bleeding. This figure coincides remarkably with that previously obtained, 32.26 per cent. in this series and 32.5 per cent. in the original. In two cases, arteriovenous malformations were found, one in association with an aneurysm of the termination of the basilar artery. No tumours were discovered. Thirty-one patients were found to have aneurysms. Eight had posterior communicating/anterior choroidal-carotid aneurysms. All were treated by proximal ligation and all are alive and show no significant morbidity.

Six had anterior communicating aneurysms. Three were treated by proximal occlusion of the appropriate anterior cerebral artery and three by clip-occlusion of the neck of the sac because of an inadequate cross circulation. Five are alive and show no significant morbidity. There was one death from meningitis which complicated the use of spinal drainage in the early postoperative treatment of a communicating hydrocephalus.

Six had aneurysms of the middle cerebral artery. Five are well and without practical morbidity. One, a woman of sixty-four years, who was stuporous before operation, died on the fifth postoperative day. In this case, the operation was too early and she might have survived had she first regained consciousness more fully.

Seven had multiple aneurysms. Three are alive and well. Four died, one as a result of an ill-timed operation, the patient being stuporose, and one died from brain swelling following thrombosis of the middle cerebral artery, the site of a second aneurysm ; the first, an anterior communicating aneurysm, was treated by occlusion of the neck of the sac, ten days before. His early postoperative state was excellent until he developed an increasing hemiparesis and coma four days later. Two others died as a result of bleeding from known anterior communicating aneurysms a few weeks after operation for a middle cerebral aneurysm. In one case it was felt in retrospect that the middle cerebral aneurysm had never ruptured but in the other, the middle cerebral aneurysm had obviously ruptured first.

Four patients were not treated by operation. One died from recurrent haemorrhage five hours before planned operation and one died in coma a few hours after admission from his second haemorrhage. The two others survived but were treated expectantly. One was arteriosclerotic and the other had an arteriovenous malformation of the posterior fossa and a basilar aneurysm.

The overall mortality for this group of cases, managed by carefully judged expectant and operative treatment and without hypothermia, is 10.9 per cent., a significant figure in the light of the mortality of over 50 per cent. with expectant treatment. The operative mortality is approximately as before, namely, 22.2 per cent., but this disappointing figure is dependent upon a determined approach to the problem of multiple

115

aneurysms. If we exclude this group, the mortality for the other twent ·
cases (two deaths), which include anterior communicating, posterio·
communicating-carotid, and middle cerebral aneurysms, is 10 per cen:.
Both these two fatalities in retrospect were avoidable, namely, meningit :
from spinal drainage, and death from an ill-timed operation, so tha:
ultimately a lower figure can be anticipated in the future.

SUMMARY

This paper is concerned with the living pathology and management of
ruptured intracranial aneurysm. It is based upon a personal experience
of eighty consecutive operations* for spontaneous intracranial
haemorrhage due to ruptured aneurysm from February 1950 to February
1956. A more recent and comprehensive series from February 1956 to
February 1958, of forty-seven patients which has accumulated partly
since this lecture was given, is briefly discussed.

There is now good evidence to support the view that patients who have
suffered from their first, and often minor, episode of subarachnoid
bleeding should be referred as a matter of urgency for neurosurgical
investigation and treatment.

ACKNOWLEDGMENTS

REFERENCES

BOTTERELL, H., *et al.* (1956, *J. Neurosurg.* **13**, 1-42.
BROWN, A. S. (1955) *Anaesthesia* **10**, 346-358.
CAIRNS, H., *et al.* (1941) *Brain* **64**, 273-290.
CLARKE, E. S., and WALTON, J. N. (1953) *Brain* **76**, 378.
COLLIER, J. (1922) *A textbook of the practice of medicine*, ed. F. W. Price, p. 1351.
   Oxford University Press, London.
DANDY, W. E. (1944) *Intracranial arterial aneurysms.* Comstock, Ithaca, N.Y.
DONALDSON, A. A. (1957) Personal communication.
DOTT, N. M. (1933) *Edinb. med. J.* (*Trans. Med.-Chir. Soc.*) **40**, 219..
————————— (1953) *Proc. Int. Congr. Neurol.*, Lisbon.
————————— (1956) Personal communication.
————————— and GILLINGHAM, F. J. (1958) *The cerebrospinal fluid circulation.* Ciba
   Symposium.
FALCONER, M. A. (1950) *Brit. med. J.* **1**, 809.
————————— (1951) *J. Neurol. Psychiat.* **14**, 153.
GARDNER, W. J. (1946) *J. Amer. Med. Ass.* **132**, 572.
GILLINGHAM, F. J. (1952) *Proc. Roy. Soc. Med.* **47**, 869-872.
————————— (1953) *Edinb. med. J.* **60**, 305.
————————— (1954) Communication to the Medico-Chirurgical Society of
   Edinburgh, December 1954 : The Surgery of ruptured intracranial aneurysms.

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*Sixteen patients in the earlier part of this series were managed together with
Professor N. M. Dott, who carried out the major part of the operative treatment.

GUIOT, G., and BRION, S. (1953) *Rev. Neur.* **89**, 578-580.
HAMBY, W. B. (1952a) *Intracranial aneurysms.* Thomas : Springfield, Illinois.
HARRIS, P., and UDVARHELYL, G. (1957) *J. Neurosurg.* **14**, 180-191.
HYLAND, H. H. (1950) *Arch. Neurol. Psychiat. (Chicago)* **63**, 61.
KINMONTH, J. B. (1952) *Brit. med. J.* **1**, 59-64.
JEFFERSON, G. (1937) *Brain* **40**, 444.
———————— (1947) *Proc. Roy. Soc. Med.* **40**, 419.
JOHNSON, R. T. (1952) *Proc. Roy. Soc. Med.* **45**, 293.
———————— (1954) Personal communication.
LENDE, R. (1955) Personal communication.
LOGUE, V. (1956) *Brit. med. J.* **1**, 473.
McCONNELL, A. A. (1937) *Zbl. Neurochir.* **2**, 269.
McKISSOCK, W., and WALSH, L. (1956) *Brit. med. J.* **2**, 559 *pp.* 560-564
MASLOWSKI, H. (1955) *Brit. J. Surg.* **43**, 1-8.
MEYER, A., and BECK, E. (1954) *Prefrontal leucotomy and related operations.* Oliver
    and Boyd, Edinburgh.
MONIZ, E. (1927) *Rev. neurol.* **2**, 72.
NORLÉN, G. (1952) *Proc. Roy. Soc. Med.* **45**, 291.
———————— and OLIVECRONA, H. (1953) *J. Neurosurg.* **10**, 404.
POPPEN, J. L. (1951) *J. Neurosurg.* **8**, 75.
SCHORSTEIN, J. (1940) *Brit. J. Surg.* **28**, 107.
SYMONDS, C. P. (1923) *Guy's Hosp. Rep.* **73**, 139.
———————— (1956) Personal communication.
TÖNNIS, W. (1936) *Zbl. Neurochir.* **1**, 39.
WALTON, J. N. (1956) *Subarachnoid haemorrhage.* Livingstone, Edinburgh.
WATSON, W. S., and GILLINGHAM, F. J. (1953) A paper read before the Society of
    British Neurological Surgeons, December 1953.

PROVINCIAL MEETING IN CARDIFF
Programme of Events

Friday, 26th September

5.45 p.m.	Reception at Cardiff Castle at the kind invitation of the Lord Mayor and City Council of Cardiff. Tickets on application to the Secretary (limited to 150).
7.30 p.m. for 8.00 p.m.	Dinner for Fellows and Members at the New Continental Restaurant, Queen Street. Tickets (£2 2s. 0d. each, inclusive of wines) on application to the Secretary. A limited number of medical guests may be invited by those attending.

Saturday, 27th September

10.00 a.m. to 12.45 p.m.	Scientific exhibitions, films and operating sessions. at the Cardiff Royal Infirmary. Open to all members of the medical profession.
12.45 p.m.	Fork lunch at the kind invitation of the Board of Governors of the United Cardiff Hospitals, in the Cardiff Royal Infirmary.
2.15 p.m.	Annual Meeting of Fellows and Members in the Reardon-Smith Lecture Theatre, National Museum of Wales.
3.15 p.m.	Admission to the Honorary Fellowship of Sir Russell Brain, Bt.
3.30 p.m. to 4.30 p.m.	" The Cervical Spine "—Lecture by Sir Russell Brain, Bt., D.M., F.R.C.P., Hon. F.R.C.S. Open to all members of the medical profession.

NOTE.—Fast trains from Cardiff to London on Saturdays leave at 5.00 p.m. and 7.00 p.m.

APPOINTMENT OF FELLOWS AND MEMBERS TO CONSULTANT POSTS

F. E. CLYNICK, M.B., CH.B., F.F.A.R.C.S., Consultant Anaesthetist to St. Peter's, St. Paul's and St. Philip's hospitals.

The Editor is always glad to receive details of new appointments obtained by Fellows and Members, either through the Hospital Board or direct.

SECONDARY TUMOURS OF THE MANDIBLE

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Leverhulme Research Fellow in Oral Pathology, Royal College of Surgeons of
England

IN THE STRICT sense of the term secondary tumours of the mandible include those which extend from a primary growth in contiguous tissues. However, the present article will be confined to those tumours whose secondary growths have been disseminated to the mandible by a route or routes other than direct extension through continuity of tissue. This means the omission of a group of tumours, the epidermoid carcinomas of the gingiva, the buccal sulcus and the floor of the mouth, whose destructive nvasion of the bone of the jaws is sufficiently common to be readily recognized.

Metastatic tumour growths are believed to arise as a result of the lodgment of tumour emboli conveyed in the blood or lymph stream. Since the existence of lymphatic vessels in bone has never been demonstrated beyond dispute, it is justifiable to assume that osseous metastases are attributable to haemic spread. Several observations lend support to this assumption. First, the coexistence of tumour deposits in bone and adjacent lymph nodes is sufficiently unusual to be regarded as fortuitous. Secondly, the microscopic identification of tumour emboli in arterioles often suggests a form of haemic distribution. Thirdly, the sites of maximal incidence of osseous metastases correspond accurately to sites in which the red marrow is found in the adult.

The importance of the marrow in relation to secondary deposits in bone probably derives from the fact that its thin-walled channels offer a suitable site for the lodgment and proliferation of tumour emboli. There is ample evidence that the sites of maximal incidence of osseous metastases correspond to the sites where red marrow is most frequently found. According to the consensus of many studies the commonest sites of bone secondaries are the vertebrae, the ribs, the pelvis, the proximal ends of the femur and humerus, the sternum and the skull. The bones of the jaws are not among the most common sites, but the existence of red marrow in the mandible, as might be expected, is also not common ; indeed, red marrow was found in only 25 per cent. of a large number of mandibles examined, and then only in small discrete patches (Box, 1933).

Nevertheless, although metastases to the mandible are not common, there is ample reason for believing that they exist more frequently than

118

has been suspected. The reason for this is twofold: first, because the clinical diagnosis of these tumours is often missed, secondly, because a thorough examination of the bones of the jaws is not part of routine autopsy technique. An indication that metastases to the mandible are readily missed is supplied by the findings of Moorman and Shafer (1954), who examined ten carcinoma patients (breast, thyroid, prostate and kidney primaries), none of whom had complained of oral symptoms. Of these, three were found to have secondary deposits in the mandible. On further questioning the authors ascertained that in two of these cases the lesion was indeed asymptomatic ; the third patient had experienced some discomfort but it was negligible compared to pain elsewhere.

It is not only in the case of the jaws that metastases may be missed. In many instances the only bones examined routinely at autopsy are the vertebrae, so that the total incidence of osseous secondaries has probably been underestimated. The comprehensive study of Abrams *et al*. (1950) was directed specifically towards the problem of determining the incidence of osseous metastases, and these workers found an incidence exceeding 27 per cent. in a series of 1,000 consecutive autopsies. In breaking down these figures they found that in the case of breast primaries more than 73 per cent. spread to bone ; the comparable figures in regard to lung and kidney primaries were 32·5 per cent. and 24 per cent. The number of cases of primary prostate and thyroid cancer in this series was insufficient for any conclusions to be drawn, but other studies have mentioned 70 per cent. in the case of the prostate and 30 per cent. in the case of primary thyroid cancer. Willis (1952) rates breast, prostate, thyroid and kidney as the primary sites most commonly metastasising to bone but in his entire list of primaries which have been known to spread to bone he makes no mention of carcinoma of the lung, an extraordinary omission at any time and one which becomes progressively more conspicuous as increasing attention is devoted to the rising incidence of bronchial carcinoma. Meyer (1957) found that by far the greatest proportion of osseous secondaries, in a series of 320 found at necropsy, were derived from bronchial primaries. In their series, Sharp *et al*. (1956) found prostate, breast, kidney, lung, thyroid and bladder to be the chief primary sites of bone-seeking secondary growths ; while the commonest primaries metastasizing specifically to the jaws were those of breast, thyroid and lung. Moorman and Shafer (1954) found the commonest primary sites of mandibular metastases to be breast, thyroid, ovary, lung, kidney, and rectum. It is clear therefore that differences in detail exist concerning the relationship of primary sites to secondary deposits in the mandible.

Certain facts emerge clearly from all reports and they are that the incidence of secondary tumours in bones is higher than that of primary tumours, that it is probably greater than is generally realised, and that

119

the manifestations are frequently occult. In respect of the jaws this is particularly true, as exemplified by the following case :

Case I

A female patient, aged seventy-one, complained of a dull ache on the left side of her lower jaw. She wore full dentures, her teeth having been extracted forty years previously, and her lower denture seemed to be causing pain which radiated from the symphysis to the temporomandibular joint on the left side. The mucosa
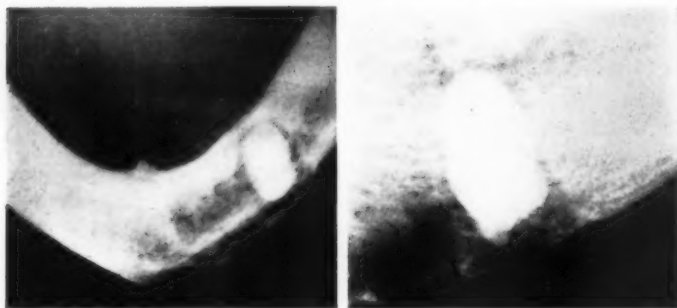
Fig. 1(a). Intraoral X-ray from Case I. The diffuse radiolucency in the vicinity of the retained root, together with the suggestion of cortical osteoplasia, was consistent with the appearance of a localised low-grade infection. Biopsy shown in Figure 2.   Fig. 1(b).   Occlusal plane X-ray of Case I.

appeared normal, but there was a slight degree of swelling from the central incisor region to the mental foramen on the left side and this area was painful on pressure. An X-ray examination revealed the presence of an area of radiolucency in the region of the symphysis. This was associated with the presence of a tooth root and was interpreted as an infective process (Fig. 1a and b). The root was removed surgically and was found to be surrounded by soft tissue. Microscopic examination revealed this as an anaplastic carcinoma, probably originating from a breast primary (Fig. 2). Subsequently a clinical examination confirmed the existence of a breast tumour and, indeed, of enlarged axillary lymph nodes.

It is obvious that in this particular instance the diagnosis of a secondary growth in the mandible would have no effect on the ultimate prognosis. It is most important, however, to realise that such is not always the case and that occasions may arise where timely recognition can be of great benefit. This may be so, for example, in the case of renal secondaries. The so-called hypernephroma is a tumour which can often be successfully extirpated surgically and which, moreover, shows a peculiar tendency to solitary metastasis. This particular tumour therefore provides an example of a cancer whose cure can be attempted with an unusually high chance of success. The thyroid gland, likewise, is a primary site from which solitary secondary deposits have been known to develop ; and in such instances again, scope for successful surgery exists. Leaving aside those cases in which both primary and solitary secondary growths may be amenable to surgery, the early recognition of metastases affords an

120

opportunity for palliative therapy. Irradiation cannot be expected to produce a cure once bodywide spread of cancer has occurred, but it does provide a means of lessening suffering during the terminal phases of malignant disease. Furthermore, the evolution of new methods of cancer

Fig. 2.   Biopsy of Case I stained with haematoxylin and eosin $\times$ 130. Showing the growing margin of an anaplastic carcinoma replacing bone.

treatment may increase the importance of recognising osseous deposits in those cases where the manifestations of the primary growth are sub-clinical. Thus, for example, spectacular success has been recorded in the eradication of certain primary and metastatic cancers of the thyroid by the administration of radioactive iodine which exerts a lethal effect on the iodine-concentrating cells of which the neoplasm is composed. Similarly hormonal therapy for carcinoma of the breast or prostate may be instituted if the recognition of a secondary tumour in bone should disclose the existence of a hitherto undiagnosed primary.

121

So far as the clinical recognition of osseous metastases is concerned there is probably no symptom of greater importance than pain, especially of an atypical nature. In the lower jaw burning and paraesthesia along the course of the inferior alveolar nerve is a frequent symptom. Loose teeth in elderly subjects, especially where this is localised to one or two teeth, should always arouse suspicion ; Sir William Kelsey Fry has attached the descriptive term " malignant loosening " to this occurrence. It is worth mentioning that a case of metastatic carcinoma within the tooth pulp has been reported (by Schmorl, quoted by Willis, 1952). A rare feature of secondary tumours, which is said to be restricted to those arising from the thyroid and the kidney, is pulsation within the growth ; this may provide a useful clue to their clinical identification.

Despite these clinical signposts even the most alert clinician would find it difficult to reach a diagnosis of secondary carcinoma of the mandible with certainty, especially if it should be of the solitary type. Nor, it would seem, is the radiologist able to do more towards diagnosis than to echo the clinician's suspicions. The only means of obtaining unequivocal confirmation is by the microscopic examination of biopsy material. However, although the diagnosis of malignancy can be reached by histological study, it is not always possible to determine the site of origin of the primary tumour.

Case II illustrates this latter point. The patient, a male aged fifty-five years, complained of stiffness and paraesthesia in the lower jaw. Eight months previously he had undergone extraction of two loose teeth, and postoperative healing had been slow and painful. The pain in his mandible had recently increased but was periodic in nature and accompanied by unilateral numbness of the lower lip. On examination, several lower teeth were found to be abnormally mobile and an incompletely healed socket was evident in the lower right third molar region. The mucosa appeared healthy. X-ray examination revealed the existence of a circumscribed radiolucent area in the ascending ramus on the right side in addition to irregular radiolucency extending for several centimetres on either side of the symphysis menti. A biopsy taken from the latter area showed replacement of the normal bone structure by squamous cell carcinoma (Fig. 3). The growth was well differentiated and bore a strong resemblance to the type of epidermoid carcinoma that is frequently seen invading bone by direct extension from a primary growth of the oral mucosa. In the absence of any such local lesion, in view of the fact that no perforation of mucosa, periosteum or cortical plate had been observed by the surgeon, and especially since a comparable lesion in the vertical ramus was evident radiographically, a diagnosis of metastatic carcinoma had to be considered. The most likely site of a primary growth giving rise to a metastasis of this type would undoubtedly be the lung ; first because these tumours metastasize to bone in a high proportion of cases, and secondly because they are not infrequently composed of squamous cells. Moreover, the incidence of bronchial carcinoma is rising and it is reasonable to assume that this will be accompanied by a corresponding increase in the incidence of osseous metastases, those to the mandible no less than any others. There are, of course, other sites of a possible primary in this case. Oesophageal carcinomas are frequently squamous-celled and on occasion they do metastasize to bone, but the absence of dysphagia reduced the likelihood of the oesophagus as a primary site. A primary tumour in the pharynx, which is often notoriously difficult to detect and diagnose, could also produce a metastatic growth of this

type. However, X-rays and other investigations have failed to disclose a primary growth, so that this particular case provides one of those rare instances of an occult primary, the identity of which may remain undisclosed until autopsy.

Fortunately not all histopathological investigations follow this pattern. It is true that many secondary tumours in bone are anaplastic in appearance and defy recognition of their origin, but equally there are
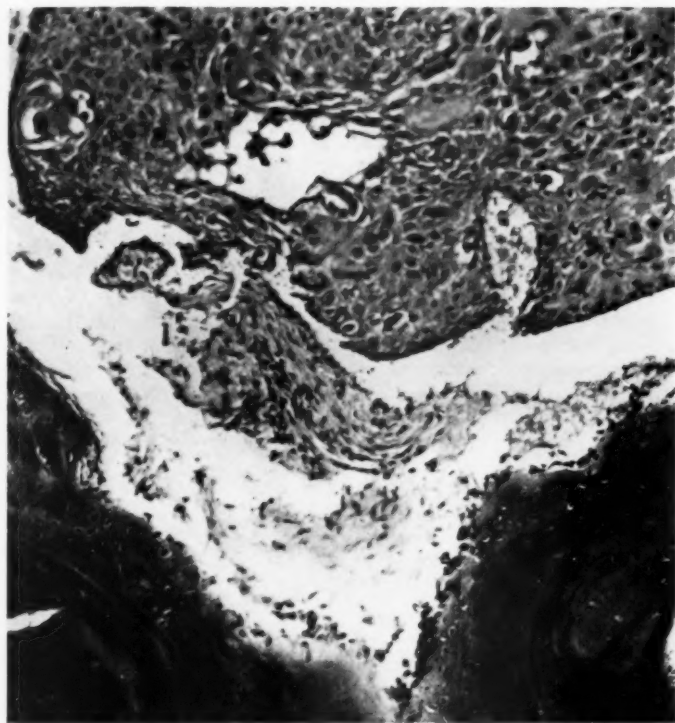
Fig. 3.   Biopsy of Case II stained with haematoxylin and eosin × 100. Showing a well-differentiated squamous carcinoma which had replaced an extensive area of mandibular bone.

important exceptions.   Thus, for example, osseous metastases of renal carcinoma reproduce the characteristic clear-celled appearance so often seen in the parent growth ; and the metastatic form of colloid-producing thyroid carcinomas carry forward this diagnostic feature.   However, the diagnosis of secondary tumours depends not only on observation of the actual cells but also on an assessment of the stromal reaction they evoke. An understanding of this important feature of secondary tumours is

123

essential to a proper appreciation of the phenomena observed in osseous metastases.

It is therefore necessary to consider the reaction of bone tissue to the introduction of a foreign element. The experiments of Fish (1952) have gone far towards clarifying those phenomena observed in irritated bone which might otherwise appear contradictory to a point of being inexplicable. By introducing infected material into cancellous bone he was able to show a variation in response at different levels. In the immediate vicinity of the irritant, bone necrosis was seen ; osteocytes had disappeared, leaving empty lacunae; nor were there osteoclasts present in this area, a fact which correlates well with the clinical observation that the roots of infected deciduous teeth fail to resorb normally. Further afield from the central necrotic focus, and where toxic material was presumably less concentrated, this author described what he called a Zone of Irritation ; here osteoclasts appeared and resorption of bone was seen to be taking place. Finally, a Zone of Stimulation was seen peripherally where presumably diffusing toxic material had become so diluted that the effect it exerted was productive ; here osteoblasts were found in profusion and the evidence of their activity was seen in the form of new bone trabeculae possessing lacunae somewhat larger and more numerous than those seen in mature bone.

The purpose of this digression is to establish a clear picture of the diverse reactions which may be seen in bone. By doing this Fish's
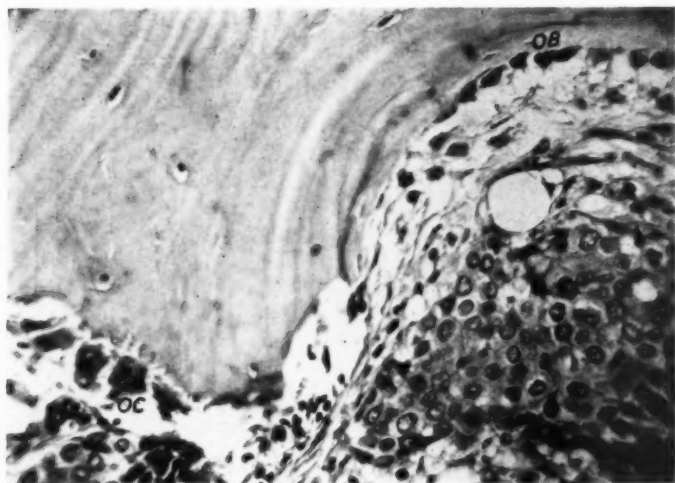
Fig. 4. Section of a secondary carcinoma which had metastasized from a breast primary to the occipital bone. Note osteoclasts resorbing bone in advance of the tumour at OC while osteoblasts have deposited new bone at OB. Haematoxylin and eosin × 500.

experiments helped to provide the basis necessary for understanding the behaviour of bone in response to a foreign material—which, for present considerations, happens to be a metastatic deposit of tumour cells. It is possible to illustrate that a comparison between the experimental findings and the response to a secondary growth can go far towards explaining reactions in osseous metastases that would otherwise appear inexplicable. There is much that remains to be explained, but in regard to detail rather than the general reaction.

There are two distinct types of secondary tumours in bone—osteolytic and osteoplastic. The former is the commoner. In most instances the growth of the secondary neoplasm is accompanied by severe destruction of bone tissue. In the contrary type the presence of tumour cells exerts a remarkable osteogenic effect, so that the lesion is characterized both radiologically and at a microscopic level by increased bone density. In some instances secondary growths originating from a common primary may produce osteolysis in some bones and osteoplasia in others ; while to render the picture even more complex the two processes may exist almost contiguously (Fig. 4).

By far the commonest osteoplastic metastases are those derived from prostate primaries ; they also originate not infrequently from cancers of the breast, especially those of the slow-growing scirrhous variety. Osteoplasia is not unusual in tumours derived from the epithelium of the urinary tract. The striking example shown in Fig. 5 derived from a carcinoma of the stomach.
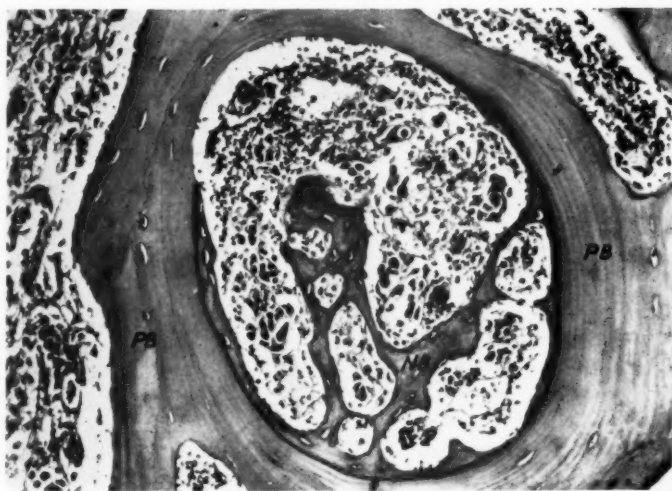
Fig. 5.   An osteoplastic secondary deposit in the sternum from a gastric primary. Premorbid bone—PB. New bone—NB. Haematoxylin and eosin × 200.

The type of bone found in osteoplastic metastases is exceedingly interesting. It is invariably well formed, the osteocytes are uniform in size, the general configuration of trabeculae conforms with that normally seen, and a peripheral echelon of osteoblasts is usually in evidence. The entire arrangement differs vastly from the true malignant bone seen in the osteogenic sarcoma. It would be as well to emphasise the differences, for although most osseous metastases are epithelial in origin, the occurrence of secondary growths from primary sarcoma has been reported. One such rarity, recorded by Martin (1925) concerns a secondary sarcoma of the mandible which metastasized from a primary growth in the femur. In a more recent and even more remarkable case bilateral metastases to the mandible originated from a primary sarcoma in the lower end of the femur (Smithers, 1958). The type of bone found in the bone-producing sarcomas is illustrated by an osteosarcoma of the femur which occurred in a female child aged eleven years (Figs. 6 and 7). The
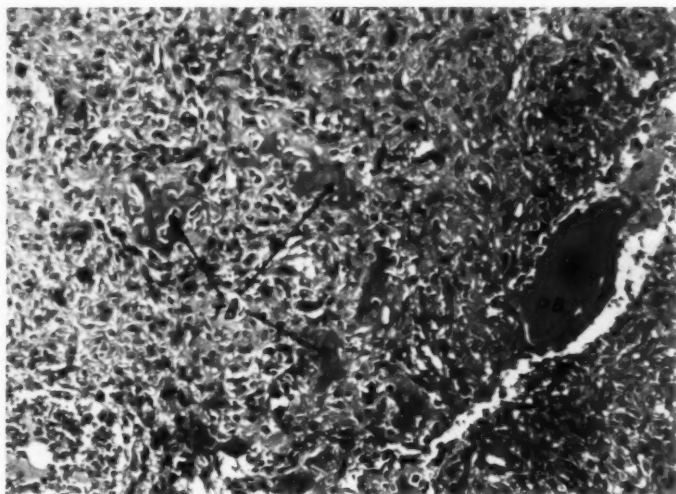
Fig. 6. Osteosarcoma. Haematoxylin and eosin × 120. Note premorbid bone, PB, and compare with the irregular trabeculae produced by the tumour cells, TB.

striking features distinguishing this bone from any other, are the absence of any vestige of aligned osteoblasts on the periphery, the chaotic irregularity in size and distribution of osteocytes, and the discrepancy between the overall trabecular pattern and that which has come to be regarded as normal (Fig. 7). This is the bone produced by malignant cells, disorderly and uncontrolled. When viewed under polarised light the fibre pattern of this tissue is seen to be rudimentary in the extreme and differs

widely from the regular features of normal bone. It has only to be com-
pared with the bone seen in osteoplastic carcinoma for the observer to
realise that the latter is not a product of the neoplastic cells but merely
a stromal response to their presence.
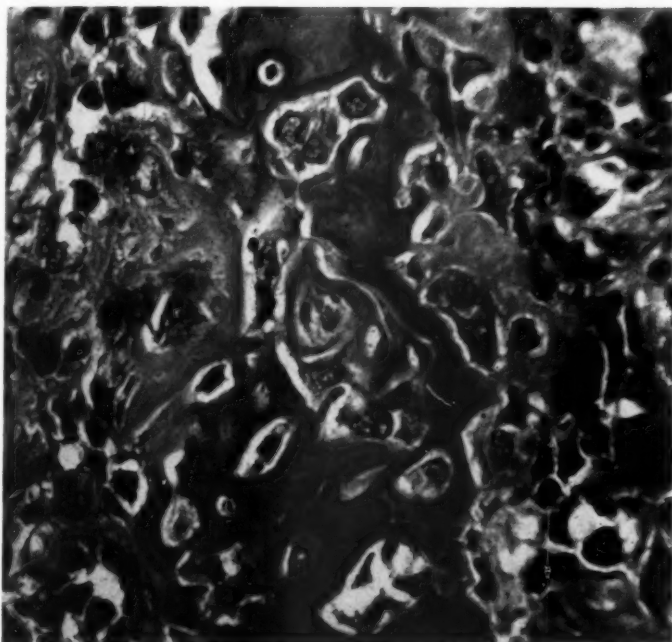
Fig. 7.   High power (× 600) of Figure 6, to show the irregular trabecular pattern
and bizarre osteocytes.

The nature of the stimulus provoking this response has not been
determined. At one time local alterations to the blood pressure were
considered to be a factor, but neither histological nor other evidence can
be adduced in support of these beliefs. Other theories have referred to
the conversion of stromal cells into osteoblasts because of the osteogenic
stimulus of necrotic fragments. This hypothesis is clearly inadmissible.
Perhaps the theory most favoured is that suggesting the diffusion of osteo-
genic chemical substances from the tumour cells. It is lent weight by the
remarkable increase in blood phosphatase levels observed in patients
suffering from prostatic cancer. These levels rise from a normal of
approximately 3.5 Bodansky units to 25 units in the case of alkaline
phosphatase ; and from a normal of less than 1 Bodansky unit to as high as
250 units in the case of acid phosphatase. The latter feature is indeed

127

diagnostic of prostatic cancer. The phenomenal alteration in phosphata se levels, when considered in conjunction with the possible role of tl is enzyme in bone formation, has contributed to the belief that diffusil le products of certain tumour cells may be the factor responsible for oste >- plasia associated with metastases. Meyer (1957) regards this correlation as unfortunate, and rejects the concept of a connection between hi h acid phosphatase levels and osteoplasia.

Apart from true neoplastic bone and the osteoplasia seen as a response to tumour infiltration, bone formation may also occur as an incidental consequence of tumour growth in those cases where secondary deposits of tumour cells are located subperiosteally. This is a fortuitous effect. Elevation of the periosteum provokes osteogenesis whatever the agent responsible for this disturbance. Subperiosteal metastases are less common than centrally located secondary growths; they probably arise from neuroblastomas more frequently than from any other type of tumour. The effect produced is an extracortical osteoplasia well-known to radiologists and often described as an onion-skin appearance when concentric lamina-tion occurs, or as sun-ray effects when radiating spicules of bone are laid down.

Two other types of bone growth associated with tumours require brief mention. Like the osteoplasia following elevation of the periosteum they both represent essentially normal responses of the host bone. The first type embraces the deposition of new bone seen at the periphery. This is completely analogous to Fish's Zone of Stimulation mentioned previously and gives the appearance of an attempt on the part of the host bone to wall off the invasive tissue.

The second type, seen more commonly in the case of primary tumours of bone, occurs when the tumour has been subjected to surgical attempts at removal at some time previous to the taking of a biopsy. In these instances incision into the tumour tissue will have provoked an attempt at healing, in the course of which deposition of normal-looking bone will take place. This constitutes a trap for the unwary pathologist and emphasizes the necessity for providing a complete history with material submitted for biopsy examination.

The subject of osteoplasia within secondary tumours of bone has been dealt with in some detail for two reasons: first, because of the interest this curious phenomenon should arouse, and secondly, because of the fact that there would appear to be less awareness of their existence than of the far more common bone-destroying metastases.

These latter, the osteolytic types, occur far more frequently and there is no doubt that the majority of secondary tumours of bone fall into the osteolytic category. The mechanism by which bone is destroyed when invaded by these tumours is not known, but their growth is usually so rapid that it would seem reasonable in many instances to attribute osteoclastic activity to the mere mechanical stimulus of considerable

pressure. It is a recognised fact that bone subjected to pressure undergoes osteoclastic resorption, and one of the few arguments put forward against the hypothesis is that evidence of osteoclastic activity is deficient ; the suggestion has been made that any multinucleated cells seen are almost certainly tumour giant cells and possess the same features, save for the number of nuclei, as the other tumour cells. This view would appear to be unacceptable. Fig. 8 depicts incontrovertibly that the giant cells associated with the crenated bone edge so characteristic of osteoclastic
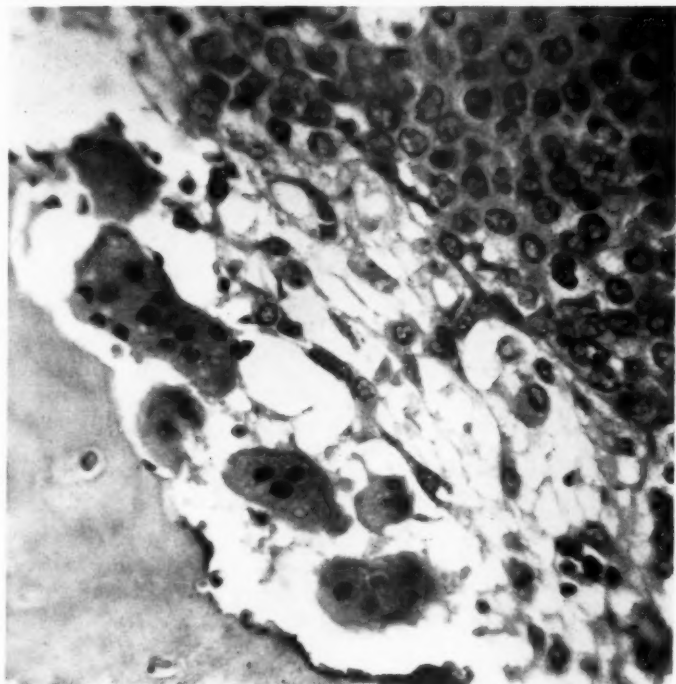
Fig. 8. Osteolytic metastasis originating from a breast primary. Haematoxylin and eosin × 500. Showing typical osteoclastic resorption of bone. Note that the osteoclasts are not aggregations of tumour cells.

activity are not aggregations of the tumour cells ; the chromatin content alone is strikingly different. It should also be remembered that if osteoclasts are not seen at the site of bone destruction this should not necessarily be taken to mean that they are entirely absent. They are known to be motile cells, and in addition their contiguity with bone may well result in their being destroyed in the process of preparing sections because of the difficulty of preserving the junction between hard and soft tissues.

129

Despite this technical difficulty there are occasions when osteoclasts can be demonstrated unequivocally in advance of the growing end of a tumour as seen in Figs. 2, 4 and 8.

At the present stage of knowledge it would be unwise to assert categorically that such is always the case. It seems probable that the degree of irritation caused by some secondary deposits, whether it be purely physical pressure or possibly a noxious chemical product of the tumour cells, may be so intense as to simulate the Zone of Necrosis where no osteoclasts could survive.

It need only be mentioned in conclusion that wherever bone destruction takes place, whether as a result of tumour growth or for any other reason, compensatory bone formation can be expected at some peripheral point provided that the rate of destruction is not so great that this protective response cannot be sustained. In the case of rapidly growing cancer this is, of course, a real possibility.

The subject of secondary growths in the mandible, or in any other bone, is one that has stimulated extensive study in the past. At the present time three factors are operating to invest this subject with additional importance : the first is that the incidence of cancer is on the increase and that these rare occurrences, the lodgment and growth of a tumour embolus within the mandible, are likely to become commoner; the second is that the development of new lines of treatment for malignant disease brings hope where none existed previously and makes the diagnosis of a secondary deposit much more than merely a matter of academic interest ; the third factor is that because radiographic examination of the teeth has become an everyday procedure the bone of the jaws comes under surveillance more frequently than any other part of the skeleton.

ACKNOWLEDGMENT

I am obliged to Mr. E. B. Brain, B.Sc., for the photomicrographs.

REFERENCES

ABRAMS, H. I., SPIRO, R., and GOLDSTEIN, N. (1950) Cancer 3, 74.
BOX, H. (1933) Canad. Dent. Res. Found. Bull. No. 20.
FISH, E. W. (1952) Surgical pathology of the mouth, p. 179 et seq. London, Pitman.
MARTIN, E. K. (1925) Tumours of Bone, Atlas of pathological Anatomy, p.26, Brit. J. Surg. Supp. to 13.
MEYER, P. C. (1957) Brit. J. Cancer XI, 509.
MOORMAN, W. C., and SHAFER, W. G. (1954) J. oral Surg. 12, 205.
SHARP, G. S., BULLOCK, W. K., and HAZLET, J. W. (1956) Oral cancer and tumors of the jaw. New York, McGraw-Hill.
SMITHERS, D. W. (1958) Personal communication.
WILLIS, R. A. (1952) The spread of tumours in the human body. 2nd ed., London, Butterworth.

RECENT OVERSEAS VISITORS

RECENT OVERSEAS VISITORS to the College have included Mr. J. Bryant Curtis, who gave a Hunterian Lecture at the College in July, and Mrs. Bryant Curtis, of Victoria, Australia, Professor A. J. Helfet of Cape Town, who gave a Hunterian Lecture in June, and Mr. and Mrs. B. T. Keon-Cohen, of Melbourne.

THE BUCKSTON BROWNE BENEFACTION

THE BUCKSTON BROWNE BENEFACTION was celebrated this year on 9th and 10th July, beginning with Professor Slome's Lecture on the Wednesday afternoon, entitled " The Buckston Browne Research Farm," and continuing the same evening with the Buckston Browne Dinner of Fellows and Members. On the following afternoon the research workers at the Buckston Browne Farm showed their progress in a number of demonstrations which were witnessed by members of the Museum and Research Committee and other interested people.

At the dinner the toast of the College was proposed by the Rt. Hon. Derek Walker-Smith, Q.C., M.P., Minister of Health, who first hailed the late Sir Buckston Browne as a great man of gregarious instincts who had founded this dinner, a most agreeable event and conducive to unanimity. After commenting on the inevitability of the Minister of Health becoming involved in high finance, he remarked how encouraging it was to find so much interest being shown in the College by the business world and such material help being given in the form of generous contributions. " To a great extent," he said, " Industrial prosperity depends on the health of the people, and therefore on the medical research and education. Good health means not only greater expectation of health but heightened vitality in the workshop. A thriving and vigorous people will enable us as a nation to keep our end up in a highly competitive life. To all of those who promote the good health of the nation, the nation's thanks are unstintingly due, and not least the thanks of all present at the dinner tonight."

The President, Sir James Paterson Ross, K.C.V.O., replied as follows :

" First let me thank you, Mr. Minister, for proposing this toast so kindly and so eloquently and with so much sympathetic understanding of what we are trying to do in this College.

" This dinner commemorates Sir Buckston Browne who is remembered in the College principally because of this dinner and because of his gift to the College of the Research Farm at Downe. Many of us have learnt a great deal more about him recently from the very interesting life which was published within the last year by Sir Cecil Wakeley and Miss Dobson.

" It was his intention that this dinner should be held primarily to enable Members and Fellows of the College to meet on equal terms. He practised as a Member of the College and was made a Fellow under the rule which permits the Council to elect Fellows from among Members of twenty years' standing—he had been a Member for fifty-two years when he was elected to the Fellowship and therefore it is understandable that he wished Members to take a prominent part at this commemorative dinner.

" Buckston Browne had a great reverence for the memory of John Hunter and Charles Darwin and it was because of his admiration for Darwin that he restored and endowed Down House in 1928—the house in which Darwin had lived and worked for forty years. It was natural, therefore, that he established his gift to the College on land adjacent to Down House and gave £100,000 for the

131

endowment for an Institution of Surgical Biological Research which was built on the land adjacent to Down House and was opened in 1933.

" At the present time under the direction of Professor Slome, who gave us an excellent account of the work going on there in a lecture this afternoon, the farm is being used to better effect than ever before, not only by workers in the College itself, but also by research workers from London hospitals and other institutions. The farm is shortly to be expanded in order to take more animals and it is very gratifying to know that such good use is being made of this gift from Buckston Browne.

" He showed his interest in scientific research in many ways but in order to indicate more clearly his thoughts on this matter I would like to quote the opening sentence of the letter which he wrote to the President when he handed over the farm.

" ' I believe those who have added, or are adding, to the Science and Art of Surgery to be the greatest of all benefactors to the Human Race, and to the domesticated animal kingdom. I therefore wish at the end of a long surgical life to do all I can to facilitate the labours of those willing to devote time to surgical observation and research.'

" Only a few laymen know of the College's research activities and even many of our Fellows and Members are unaware of them and would be extremely interested to visit our scientific departments, and to see the number and variety of problems which are under investigation, all with a direct bearing upon the practice of medicine and surgery and dentistry, the treatment of disease and the alleviation of suffering.

" Recently I have been reading with great interest the life of Sir Walter Fletcher, the first Secretary of the Medical Research Council who, when giving an address on medical research to a distinguished lay audience, likened a new scientific discovery to the fruit of a tree—people see and hear of the fruit which has been plucked for their needs, but know little enough about the tree from which it has been gathered. He reminded them of what Bacon wrote :

" ' If you will have a Tree bear more fruit than it has used to do, it is not anything you can do to the boughs, but it is the stirring of the earth, and putting new mould about the roots, that must work it.'

" The research work of the College is like such a tree with great branches of Anatomy and Physiology, Pathology and Biochemistry and Pharmacology, Dental Science and Anaesthetics and Ophthalmology, and we must ever bear in mind the patient and devoted labours of those who have toiled to make the tree more productive.

" Furthermore we must remember that the cultivation of such a tree is a costly business, and therefore we have founded a horticultural society—if Lord Kindersley will allow me to call it so—whose members enable us to pay the wages of the gardeners, and to provide them with the necessary tools and equipment and fertilizers. We remember most gratefully their interest in our labours and their practical assistance without which the tree would wither, but with which we can look forward with confidence to a rich harvest.

" It is a comforting thought that the members of this horticultural society are not wasting their subscriptions ; they may have some return for them merely from the satisfaction of supporting a worthy cause : but they are likely to reap a much more material and substantial benefit because it is of the utmost importance to every individual, whatever his status or interests, that this tree should be fruitful, for its fruit is for the benefit of every one of us, and may indeed bring healing to all mankind."

Sir Archibald McIndoe, C.B.E., Vice-President, proposing the health of the guests, first welcomed " the real objects of our hospitality—the

Fellows and Members for whom Sir Buckston Browne instituted this Dinner." Many hundreds of surgeons had over the years dined in the College as its guests, and, at the same time, had learnt something of the work and character of their great parental organisation. He hoped that young surgeons from many parts of the Commonwealth enjoying this privilege tonight would continue to remember the College with the warmth and affection with which it was now regarding them.

Turning to particular guests, he mentioned first the Minister of Health, " a witty and brilliant speaker who fills his high office with great distinction. We hope he will be long in office.

" To add dignity to our proceedings we have the Very Rev. A. C. Don— Dean of Westminster—an old and valued friend of the College.

" Official London is represented by Mr. Thomashoff who himself represents the High Commissioner for South Africa.

" Sir John Charles, Chief Medical Officer of Health, is one of the staunchest friends of the College and is remarkable for the skill with which he pilots his overladen bark at the Ministry of Health.

" Sir Bennett Hance represents the Commonwealth Relations Office, and another old friend is General Sir Alexander Drummond, Director-General of the Army Medical Services."

Sir Archibald next welcomed the Presidents of other Colleges and kindred institutions, and finally a number of guests who had shown a deep interest in the affairs of the College and had given great practical help in its finances. Among them he mentioned Sir Arthur Sims, Sir Edward Baron, Mr. Edward Lumley and Mr. Norman Laski (repre- senting Sir Simon Marks), as well as the Directors of several companies. He acknowledged the indebtedness of the College to its Appeal Com- mittee, and especially Lord Kindersley, the Chairman.

Sir Harry Jephcott replied for the guests and, after expressing thanks for hospitality, spoke of the work of the College and particularly that of its Fellows overseas whose services continued to be greatly in demand and greatly valued in those countries of the Commonwealth now gaining their independence.

He concluded :

" I am quite sure that all your guests here this evening will wish me to thank you, Mr. President, and the members of the College, not only for your hospitality which we have so greatly enjoyed, but for the outstanding work which you are doing in maintaining British prestige, both by the works of your Fellows overseas, and also in welcoming students from the developing countries of the Common- wealth to this great seat of medical science and learning.

" It is with that thought in our minds that your guests echo the words of the Grace and say ' may wisdom and prosperity always be with you.' "

ANATOMICAL MUSEUM

THE SPECIAL DISPLAYS are temporarily discontinued owing to reorganiza- tion of the museum.

THE INTERNATIONAL FEDERATION OF SURGICAL COLLEGES

THE FEDERATION WAS formally inaugurated in Stockholm on 4th July 1958. The Federation is representative of Surgical Colleges, Academies and Surgical Institutions throughout the world, but not of individual persons, and the foremost of its stated objects are :

(1) The establishment and maintenance of close relations among approved surgical colleges and kindred institutions, and

(2) Encouragement of the maintenance of high standards of education, training and research in surgery and its allied sciences.

The Stockholm meeting was held during the Sectional Meeting of the American College of Surgeons held in conjunction with the Swedish Surgical Society. The morning session was a business meeting of the Federation Council and, thanks to the hospitality of the American College of Surgeons, was held on board the S.S. Statendam which they had chartered to bring their Fellows to the meeting. The Council was also indebted to the American College for a most delightful luncheon on board.

At this Council meeting Professor Sir Harry Platt, Bt., was elected President for the ensuing three years and Dr. I. S. Ravdin (U.S.A.) and Dr. E. Dahl-Iversen (Denmark) were elected Vice-Presidents.

The Executive Committee in the first instance will consist of representatives from Holland, France, Sweden, Norway, Belgium, and Australasia in addition to the President and Vice-Presidents.

The Member-Institutions are as follows :

Academy of Surgery of Paris
American College of Surgeons
Belgian Surgical Society
College of Physicians, Surgeons and Gynaecologists of South Africa
Danish College of University Surgeons
Dutch Association of Surgeons
Italian Surgical Society
Norwegian Surgical Association
Royal Australasian College of Surgeons
Royal College of Physicians and Surgeons of Canada
Royal College of Surgeons of Edinburgh
Royal College of Surgeons of England
Royal College of Surgeons in Ireland
Royal Faculty of Physicians and Surgeons of Glasgow
Swedish Surgical Society.

The Secretary and Treasurer of the Federation is Mr. Kennedy Cassels who will carry out the administrative work from his office in the Royal College of Surgeons of England.

In the afternoon of the same day the Federation held an open meeting in the Concert Hall, the headquarters of the American College's meeting.

134

Sir Harry Platt, as President of the International Federation, was in the Chair, and after he had spoken of the inauguration of the Federation and described its aims, four other members of the Council made suggestions about the future of the Federation and its possible activities. These were :

Dr. Carl Semb of Oslo, representing the Norwegian Surgical Association.

Dr. J. F. Nuboer, of Utrecht, representing the Dutch Association of Surgeons.

Professor Sir James Paterson Ross, President of the Royal College of Surgeons of England, speaking on behalf of the British Commonwealth.

Dr. I. S. Ravdin, of Philadelphia, Chairman of the Board of Regents of the American College of Surgeons.

Questions were then asked from the body of the Hall and answered by the Chairman.

BOOKS ADDED TO THE LIBRARY APRIL-JUNE 1958

Anatomy
> LeGros Clark. Tissues of the Body. 4th edition.

Cytology
> Murphy (editor). Symposium on metabolic aspects of Transport across Cell-membranes.

Embryology
> Dalcq. Introduction to general Embryology.

Biochemistry
> Davidson. Biochemistry of Nucleic Acids. 3rd edition.
> Harrison. Chemical methods in Clinical Medicine. 4th edition.
> Morawitz. Chemistry of Blood Coagulation.
> Neuman and Neuman. The chemical Dynamics of Bone Mineral.

Physiology
> Allen (editor). Extra-corporeal Circulation.
> Bergan. Investigation of relative function of right and left Lung by Broncho-spirometry. Gift of Professor Carl Semb (Oslo).
> Bullock (editor). Physiological triggers and discontinuous rate processes ; a symposium.
> Ciba. The cerebrospinal fluid.

Neurology
> Greenfield and others. Neuropathology.
> Penfield. The excitable Cortex in conscious Man.
> Richter. Metabolism of the Nervous System.
> Wartenburg. Neuritis, sensory Neuritis, Neuralgia.

Pharmacology
> British Pharmacopoeia 1958.
> Dreisbach. Handbook of Poisons.
> Marler. Pharmacological and chemical Synonyms. 2nd edition.
> Martindale. Extra Pharmacopoeia. 24th edition, volume 1.

Radiology
> Davidson. Biological Effects of whole body γ-radiation on Human Bodies.

Surgery
> Dudley and others. Principals of general surgical Management.
> Quénu. Nouvelle Pratique chirurgicale illustrée. Part XI. Gift of British Journal of Surgery.
> Rob and Smith. Operative Surgery. Vol. 7. Gift of Mr. M. L. Formby (continuation).
> Souttar (Editor). Textbook of British Surgery. Vol. 3. Publishers' gift.
>> Sir Henry Souttar has presented a second set of Vols. 1-3.
> Welch and Powers. The Essence of Surgery.
> White and Dennison. Surgery in Infancy and Childhood.
> Yudin. Reparative Surgery for impassable Oesophagus (in Russian).
> Yudin. Studies in abdominal Surgery (in Russian). Both presented by State Medical Library, Moscow.

Orthopaedic Surgery
GILLIS. Artificial Limbs. Author's gift.
GUILLEMINET AND RICARD. Pseudarthrose congénitale du Tibia. Gift of Mr. P. A. Ring, F.R.C.S.
JAKOBSEN. Vitallium mould Arthroplasty for Osteoarthritis of Hip-joint. Gift of Professor Carl Semb (Oslo).

Thoracic Surgery
JOHNSON AND KIRBY. Surgery of the Chest. 2nd edition.
LANGSTON (editor). The post-operative Chest.
THORAXCHIRURGIE, Vols. 1-5, and continuation (a periodical). Gift of Dr. G. R. Graham.

Cancer
RAVEN. Cancer. Vol. 3. Author's gift, continuation.
RUSBY. Carcinoma of the Lung.

Cardiology
BOGOSLAVSKIJ. Constrictive Pericarditis (in Russian). Gift of State Medical Library, Moscow.
HEYMANS AND NEIL. Reflexogenic areas of the Cardiovascular System. Publishers' gift.
NATOF AND MOORE. Cardiovascular Collapse in the Operating room.

Dental Surgery
TOVERUD. Influence of war and post-war conditions on the Teeth of Norwegian children. Gift of Sir Wilfred Fish.

Anaesthesia
MACINTOSH. Lumbar Puncture. 2nd edition. Gift of Dr. Frankis Evans.
MACINTOSH AND OTHERS. Physics for the Anaesthetist.

Ophthalmology
DUKE ELDER. A Century of International Ophthalmology. Author's gift.
LYLE AND LYLE. Applied Physiology of the Eye.
SIVASUBRAMANIAM. Student's Companion in Ophthalmology. Author's gift.
SORSBY (editor). Systemic Ophthalmology. 2nd edition. Editor's gift.
JOHN WEISS AND SON. Ophthalmic Instrument Catalogue. Editor's gift.
TRANSACTIONS OF THE AMERICAN ACADEMY OF OPHTHALMOLOGY. Vol. 62, 1958, in continuation (a periodical). Gift of Institute of Ophthalmology, New York.

Therapeutics
EOLIAN. Penicillin Treatment of surgical Infections (in Russian). Gift of State Medical Library, Moscow.
JAMES. Diagnosis and Treatment of Infections.

Reference Book
ASSOCIATION OF SPECIAL LIBRARIES. Aslib Directory to Sources of Information.

Historical Texts
BRUNNER, J. C. (1653-1727). De glandula pituitaria. 1688.
FABRICIUS OF AQUAPENDENTE (1533-1619). Le Pitture dell' Anatomia, edited by U. Stefanutti. Editor's gift.

History of Medicine
BAUER, K. H. Ueber Fortschritte der modernen Chirurgie. Author's gift.
BAUER, K. H. Die deutschen Chirurgenkongresse seit der 50. Tagung. Author's gift.
JACKSON, H. M. The story of the Royal Canadian Dental Corps.
PASTEAU. O. La chirurgie urinaire en France, XIII-XIX siècle. 1908.
A companion volume to the author's Les instruments de chirurgie urinaire en France (1914), presented by Lord Webb-Johnson in 1945.

Biography
BELL : Gordon-Taylor and Walls. Sir Charles Bell. Gift of Sir Gordon Gordon-Taylor.
GORDON : Porter. Alexander Gordon (1752-99) of Aberdeen. The College possesses Gordon's Treatise on epidemic puerperal fever (1795).
GRAHAM : Addresses at the memorial service for Dr. Evarts Graham (Hon. F.R.C.S.), St. Louis 1957. Gift of Sir Russell Brock.
HUNTER : Merriman. John Hunter, a Kensington worthy. 1890. Gift of Sir Arthur MacNalty.
McMURRAY : McFarland. The life and work of T. P. McMurray.
NIGHTINGALE : Cope. Florence Nightingale and the doctors.
OSGOOD : Harvard Faculty. Minute of appreciation of R. B. Osgood. Gift of Mr. Norman Capener.
SHERRINGTON : Cohen. Sherrington : physiologist, philosopher, and poet. Publishers' gift.

136

THE SEVENTH INTERNATIONAL CANCER CONGRESS

THE SEVENTH INTERNATIONAL Cancer Congress took place in London from 6th-12th July 1958, under the auspices of the International Union against Cancer. The Congress was held at the Royal Festival Hall and 2,500 delegates from sixty-four countries were present at the Opening Ceremony on Monday, 7th July.

Professor J. H. Maisin, President of the International Union against Cancer, opened the proceedings by installing Sir Stanford Cade, K.B.E., C.B., as President of the Congress.

His Royal Highness The Duke of Gloucester, officially opening the Congress, welcomed the members to London. He referred to the interest and sympathy which members of the Royal Family had always taken in cancer research, and said that he himself had been President of the British Empire Cancer Campaign for many years so that he fully realised the magnitude of the problem confronting research workers. An international congress united people from many lands who, although thinking and speaking in different tongues, were inspired to work for the same goal, and the interchange of ideas and united efforts would do much to alleviate suffering. Wishing the delegates God-speed, the Duke then declared the Congress open.

Sir Stanford Cade, in his Presidential address, told the members that he had, on their behalf, sent a message to Her Majesty The Queen, Patron of the Congress, and had received the following reply :

" Please convey to all delegates attending the Seventh International Cancer Congress an expression of my sincere thanks for their kind message.

" I welcome them to London and join with them in the hope that their deliberations will lead to greater knowledge of the disease and thereby to the alleviation of human suffering.

ELIZABETH R."

Sir Stanford then thanked the Duke of Gloucester for his interest and encouragement and his graciousness in consenting to open the Congress. He paid tribute to the late Lord Horder, whose death had prevented him taking office as President of the Congress, and whose place Sir Stanford had taken. Tribute was also paid to Professor Sir Ernest Kennaway, whose death had occurred this year, and whose contributions to cancer research had included the identification of carcinogenic substances.

The purpose of the Congress, Sir Stanford continued, was to take stock of present day knowledge concerning the problems confronting research workers : all the various aspects of cancer and approaches to research in this field would be considered and ideas exchanged. Cancer was the universal enemy of mankind and needed the united international effort of varied talents and skills to join in the common fight against the common foe, and it was not unreasonable to hope that the Congress would con-

137

tribute to the solution and bring workers nearer to the day when victory over cancer would be achieved, as victory over other ills had been achieved. The Congress might define the strategy on which the tactical battles would be fought during the next few years ; knowing no national frontiers, no parochialism of thought, no restriction of individual responsibility, it accepted as its object the pursuit of truth. The nature of the problem brought many disappointments, much disillusionment and often failure, and the corner-stone of the undertaking was courage, courage of thought, a spiritual courage which bred an aggressive inquisitiveness, courage which transgressed the limits of the seemingly impossible, courage to bear defeat without losing heart, courage which, in fact, did not accept defeat.

Sir Stanford concluded his address by quoting the words inscribed beneath the bust of Longfellow, in the Hall of Fame,

" The heights by great men reached and kept
were not attained by sudden flight,
But they, while their companions slept,
were toiling upwards in the night"

and said that surely the day would come when the toil would be accomplished and the last International Cancer Congress would be held, as others would no longer be needed.

An expression of thanks by Professor A. Prudente, the President of the Sixth International Cancer Congress, closed the Opening Ceremony.

PROCEEDINGS OF THE COUNCIL IN JULY

PROFESSOR SIR JAMES PATERSON ROSS was re-elected President at a meeting of the Council held on 10th July. Sir Archibald McIndoe was re-elected and Mr. A. Dickson Wright was elected Vice-President.

Dr. Warren H. Cole of Chicago, and Dr. Charles W. Mayo of Minnesota were admitted as Honorary Fellows.

Dr. H. J. Windsor, of Brisbane, was admitted to the Fellowship, having been elected as a Member of 20 years' standing.

The Hallett Prize was presented to Miss Mohini V. Ramchandani of the University of Bombay.

Professors and Lecturers for the ensuing year were appointed as follows :

Hunterian Professorships

(*Lectures on Comparative Anatomy and other subjects, illustrated by preparations from the Hunterian Collection and other contents of the Museum, by Fellows and Members of the College.*)

W. E. TUCKER.—One lecture on Traumatic syndrome phases and stages : certain injuries, their prevention and treatment.
R. A. MOGG.—One lecture on Congenital anomalies of the urinary tract in relation to disorders of micturition.
E. M. NANSON.—One lecture on Tumours of the parotid gland.
J. B. CURTIS.—One lecture on Sub-arachnoid haemorrhage and intra-cranial aneurysms.
C. J. KAPLAN.—One lecture on An appraisal of conservative therapy in skeletal tuberculosis.
P. H. JONES, M.V.O.—One lecture on Lobectomy and bronchial anastomosis in the surgery of bronchial carcinoma.

G. J. HADFIELD.—One lecture on Hormone deprivation in breast cancer spontaneously arising or surgically induced.

A. G. PARKS.—One lecture on The micro-anatomy of the breast.

T. J. S. PATTERSON.—One lecture on Congenital deformities of the hand.

J. W. DICKSON.—One lecture on Pathological ossification in nervous disease with special reference to traumatic paraplegia.

C. HAVARD.—One lecture on Non-malignant bile duct obstruction.

A. J. DAVIES.—One lecture on Carcinoid tumours (argentaffinomata).

G. S. M. BOTHA.—One lecture on The closing mechanism between stomach and oesophagus and its importance in surgery of the gastro-oesophageal junction.

J. S. CALNAN.—One lecture on The surgical treatment of speech disorders.

Arris and Gale Lectureships
(Lectures on subjects relating to Human Anatomy and Physiology.)

E. R. SMITH.—One lecture on The anatomy and physiology of the bile and pancreatic ducts and their surgical significance.

G. L. BOURNE.—One lecture on The anatomy, physiology and pathology of the human amnion and chorionic membranes.

K. M. BACKHOUSE.—One lecture on The gubernaculum testis Hunteri, testicular descent and maldescent.

Erasmus Wilson Demonstratorships
(Demonstrations on the Pathological contents of the Museum by the Pathology Curator or some other duly qualified person or persons.)

R. GOODBODY.—One Demonstration.

K. M. LAURENCE.—One Demonstration.

L. W. PROGER.—One Demonstration.

R. C. B. PUGH.—One Demonstration.

H. A. SISSONS,—One Demonstration.

M. O. SKELTON.—One Demonstration.

Arnott Demonstratorships
(Demonstrations on the contents of the Museum by the Conservator of the Museum or some other duly qualified person or persons.)

J. DOBSON.—One Demonstration.

A. A. BARTON.—One Demonstration.

A. HOWE.—One Demonstration.

R. J. LAST.—One Demonstration.

R. M. LIVINGSTON.—One Demonstration.

B. COHEN.—One Demonstration.

Examiners for the Diploma in Anaesthetics and for the Fellowship in the Faculty of Anaesthetists for the ensuing year were appointed as follows :

Diploma in Anaesthetics
Professor Sir Robert Reynolds Macintosh.

F.F.A.R.C.S. Examinations
PRIMARY EXAMINATION (Anatomy)—G. W. Causey, D. V. Davies.
(Physiology)—D. Slome, E. A. Pask.
(Pathology)—G. J. Cunningham, H. A. Magnus.
(Pharmacology).—H. C. Stewart, W. D. M. Paton.
FINAL EXAMINATION (Anaesthetics)—F. T. Evans, W. W. Mushin, G. S. W. Organe, B. R. M. Johnson, R. F. Woolmer, C. L. Hewer, J. Gillies, H. J. Brennan.
(Medicine)—A. Kekwick.

A diploma of Fellowship was granted to one candidate and Licences in Dental Surgery to 40 candidates.

Dr. Geoffrey Organe was co-opted to the Council as a representative of Anaesthetics.

Dr. Ivan Whiteside Magill, Dr. Robert James Minnitt, Dr. Edgar Stanley Rowbotham, Sir Henry Sessions Souttar, and Dr. Ralph Milton Waters were elected Honorary Fellows in the Faculty of Anaesthetists.

139

The following hospitals were recognized under paragraph 23 of the Fellowship Regulations :

HOSPITALS	POSTS RECOGNISED		
	General (all 6 mths.)	Casualty (all 6 mths.)	Unspecified (all 6 mths.)
BLACKBURN — Blackburn Royal Infirmary (additional)			Under para 23(c) Temp. recognition until June, 1959 S.H.O. (E.N.T.)
PLYMOUTH—South Devon and East Cornwall Hospital (additional)	2 Surg. Regrs.		
LONDON — Hackney Hospital (additional)		Cas. Off.	
NORWICH—Norfolk and Norwich Hospital (additional)			Regr. (Orth.)
WORKINGTON—Workington Infirmary (additional)			H.S. (Surg., Orth. and Cas.)
NEWCASTLE—Newcastle General Hospital (additional)			S.H.O. (Orth.)
NORTHALLERTON — The Friarage Hospital (additional)	S.H.O.		
HARTLEPOOLS—Hartlepools Hospital (additional)	Surg. Regr.		
BIRMINGHAM—Selly Oak Hospital (additional)	2 Surg. Regrs.		
SHREWSBURY—Eye, Ear and Throat Hospital (additional)			Under para 23(b) Regr. ⎫ Ophth. S.H.O. ⎭
PRESTON—Preston Royal Infirmary (Redesignation)			Redesignation of H.S. (Neurosurg.) to S.H.O. (Neurosurg.)

DIARY FOR AUGUST

There will be no lectures at the College during August, but the Museums and Library will remain open.

DIARY FOR SEPTEMBER

Mon.   1   Basic Sciences Lectures and Demonstrations begin.
Wed.   3   College closed for Staff Outing.
Wed.   10   Second L.D.S. Examination begins.
Wed.   17   D.C.H. Examination begins.
Thur. 18   Pre-Medical Examination begins.
Wed.   24   D. Orth. Examination begins.
Thur. 25   First Membership Examination begins.
Fri.   26   5.00 Board of Faculty of Dental Surgery.
Sat.   27   Annual Meeting of Fellows and Members in Cardiff.
Tues. 30   Final Membership Examination begins.

3

WOUND INFECTION

Moynihan Lecture delivered at the Royal College of Surgeons of England
on
6th May 1958
by
H. Rocke Robertson, F.R.C.S.Ed., F.R.C.S.(C.), F.A.C.S.*
Professor of Surgery, University of British Columbia

I AM VERY conscious of the honour involved in the award of this lectureship and grateful for the privilege of addressing this College. At the same time I present my subject with some trepidation realizing fully that to discuss wound infection at a moment when such great advances are being made on all surgical fronts is to introduce a discordant note into an otherwise triumphal marching song. But I make no apology— for I think it likely that the problem of hospital infection in general, and wound infection in particular, is a very real one the world over. Reports from all quarters reveal the same story—boils, pneumonias, enterocolitis, urinary and wound infections occurring with always annoying and occasionally alarming frequency. The staphylococcus, while not the only offender, is the main cause of the trouble and it is with the lesions that it causes that we have been primarily concerned.

Whether this problem of hospital infection is greater now than in the past is an academic question that cannot be answered with confidence. One's impression is that infections of this type were relatively infrequent before the war, but precise information on either past or present experience is not available to provide the answer, and no answer should be attempted without it, for one's memory—particularly of things distasteful —is often erroneous. The important fact is that in many hospitals at the present time infection is rife. It would be too much to suggest that all hospitals are affected, but I think it is true to say that all who have searched for trouble have found it.

We became fully aware of our own difficulties in 1950 on the occasion of a visit by a distinguished British surgeon. As he walked about our wards we realized, for the first time, that all too many of our cases were infected. Our visitor had that unfortunate capacity, peculiar to able people of his sort, for singling out the bad cases—in this instance the infected ones—and the round seemed endless. The episode was of value to us, however, for we were stimulated to look into the matter. A committee was formed, meetings were held, the authorities were consulted and, in due course, a plan of action consisting of the changing of some ward and theatre techniques was evolved and put into effect. The immediate results were gratifying and for a time it appeared that all would be well. But as sepsis recurred, the inadequacies of our patchy

controls were revealed and further measures were introduced. With each down-swing in the incidence of wound infection our spirits rose, but never was a good record maintained. After four years of what now appear to be half-hearted efforts to improve our results, we came to realize that we had achieved very little. At best we had learned that the problem was a complex one, that the control of infections involved more than the perfection of theatre and dressing technique, and that wound infection was in some degree related to the other types of hospital infection to which our patients all too frequently fell victims. This, we felt, was an important concept—differing in some respects from that held by others; for they, at least in their writings, focused on the operating theatre, usually paying scant attention to the possibility that contamination of the patient or the surgeon in the ward itself might result in a wound infection no matter how meticulous the theatre technique.

It seemed to us unlikely that we could produce optimum results unless we attacked the staphylococcus at every possible point. A new committee was formed composed of the heads of the administrative, nursing, laboratory and clinical services involved in the rather far reaching plans that we gradually developed. The principal measures instituted by this committee are summarized in Table I. Many of these items are self-explanatory but special mention should be made of :

1. *The Isolation Ward.* Early on in the programme, a ward in the hospital was set aside to receive infected patients on admission and transfers from the rest of the hospital of patients who developed infection in the hospital. These patients went to a " septic " theatre in the main operating suite and to the X-ray department, &c. After a year, an isolation unit was set up in a separate building with all its own facilities and it was then possible to maintain much more careful technique. Occasionally seriously ill cases in hospital who develop infection have to be kept in their own ward because of some special care they are receiving and in these instances a type of barrier technique is set up. As a rule it has been possible to place infected patients in separate rooms, but it is quite evident that it is practically impossible to prevent contamination of the surrounding areas even with the most careful type of barrier technique or room isolation and we discourage the practice of keeping patients in the main hospital area.

2. In order to be as certain as possible that all personnel who develop an active infection in the form of boils, &c., will report so that they may go off duty, it has been necessary to find means of continuing their pay while off duty. Before this arrangement was made, it was our experience that certain members of the staff would fail to disclose their infection.

3. The development of a technique for laundering blankets in such a way as to free them of staphylococci and still to preserve the blanket has taken some time. At present, a technique using a chloramine anti-

TABLE I

SUMMARY OF INFECTION CONTROL MEASURES.   SHAUGHNESSY HOSPITAL.

1. Isolation ward—Admissions and transfers. Barrier care on wards where transfer impractical.
2. Eliminate from contact with patients all personnel with active infection.
3. Blankets—Laundered—clean set for each patient.
4. Mattress—Autoclave. Washable or plastic cover. Fresh for each patient.
5. Pillows—Laundered set for each patient.
6. Laundry—Separation dirty and clean in transport and in laundry.
   Soaking infected linen before laundering.
7. Abandon dry dusting, sweeping, floor polishing in patient area.
8. Decontamination—Baths, toilet seats.
9. Increase washing facilities. Abandon cake soap. Encourage showers.
10. Wound area prep.—Sterile in O.R.
11. Decontaminate anaesthetic apparatus.
12. Check ventilators.
13. Check all sterilizing procedures.
14. Impervious aprons for surgeon and assistants.
15. Impervious wound drapes.
16. Wound irrigation with saline.
17. Antiseptic dressings around drains.
18. No touch dressing technique.

septic is in use and frequent checks have shown it to be fairly effective though not yet completely so.

4.   Contamination of mattresses has been proved on many occasions. The use of formalin vapour in an autoclave has been found to be effective in eliminating staphylococci from mattresses.   However, this technique is time-consuming. A mattress cover made of ticking material impregnated with oil and C.P.B. has been in use for a considerable time now and has proven itself efficient and easy to manage.

11.   Various pieces of anaesthetic apparatus were shown in the past to be contaminated with staphylococci. The main items in our present technique are :

(a) To autoclave all intratracheal tubes.

(b) Thoroughly to cleanse with G11 soap and a mild antiseptic (C.P.B.) the rubber tube connectors.

12.   Frequent checks of the ventilating system are made to make certain that a positive pressure in the operating theatre itself is maintained.   On occasions adjustments of the fans have had to be made.

14.   Surgeons and assistants are required to wear light plastic aprons beneath their operating gowns to prevent contamination at such times as their gowns become wet with blood or fluid.

15.   Impervious wound drapes of a light plastic material are used wherever possible to protect the wound edges from contamination particularly in operations in which a hollow viscus is to be opened. When these drapes are used, the appearance of the subcutaneous tissue and the muscle at the end of a long operation is very much healthier than when these tissues are exposed to the drying effect of the air and the heat of the operating lamps, such as occurs when only the skin is protected by towels.

143

16.   Irrigation of the wound with saline is thought to be effective, at least in so far as it washes out small fragments of fat and avascular debris which are ordinarily invisible and otherwise would remain in the wound.

17.   We have in the last year adopted a technique of applying anti-septics (metaphen) to the dressings around Penrose drains, T-tubes, &c. It has been instructive to us to see how the skin surrounding the emerging tube remains normal in all respects when antiseptics are applied whereas when they are not applied, frequently there is some redness and discharge about the tube.

It can readily be appreciated that the nuisance and the cost of some of these measures are so great as to cause hospital authorities and medical staff seriously to question the necessity. Intent as they may be to ensure the safety of the patients in their hospitals they are, reasonably enough, reluctant to embark upon such a programme without substantial evidence to support it. The establishment of an isolation unit, the frequent launder-ing of blankets and pillows and the handling of mattresses are the items that involve the greatest inconvenience and expense. To justify their inclusion in a plan, we found it necessary to establish certain points.

(*a*) That an infected patient will contaminate his surroundings.

(*b*) That the organisms that he spreads about remain virulent for a long time.

(*c*) That contamination on the wards leads to a higher incidence of infection in the patients.

(*d*) That to group together patients with staphylococcal infection in an isolation unit neither condemns the patient to continued infection nor exposes the nurses and orderlies to unusual danger of infection.

(*a*) The first point was relatively easy to deal with. It might, indeed, be regarded as self-evident that an infected patient would contaminate all about him, but so damaging at times are the questions of the sceptics that we thought it desirable to settle the issue by the following experiments (Fig. 1). Into a room that has been thoroughly cleaned and in which the bedding, the mattress, pillows, bath tub, &c., were shown by culture to be free from staphylococci, a pair of patients with discharging staphy-lococcal lesions was admitted. Within forty-eight hours staphylococci of the same bacteriophage type as that grown from the patients were re-covered from all the objects previously shown to be free. This experiment has been repeated several times with substantially the same results.

By way of control, it has been shown that the room similarly cleaned, but left unoccupied, or occupied by patients without infection and with negative skin and nasal cultures would generally remain free from staphylococci for a considerable time. Patient carriers introduced into such a room would, for no obvious reason, cause widely variable degrees

of staphylococcal pollution. In no instance have the carriers caused as great a degree of pollution of their environment as have the worst cases of clinical infection.
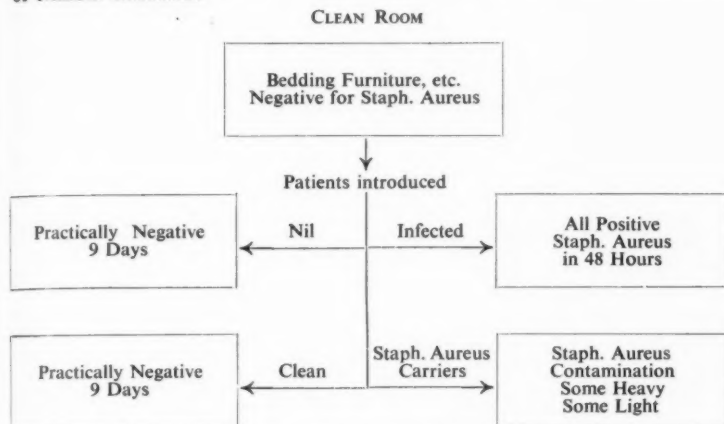
CLEAN ROOM

Fig. 1.   Clean room experiment.

(*b*)   The question raised by the next point was " Does the staphylococcus shed by a patient or a carrier maintain its virulence ? "   This is difficult to answer for there is no simple test of the virulence of this particular organism.   By animal experimentation it has been possible to show that threads which were infected with cultures of a staphylococcus and allowed to dry for two weeks would, when inserted into a rabbit's skin and left there, regularly produce active abscesses while sterile threads similarly placed produced no reaction.   Such tests, though conclusive in the experimental animal, are, however, not entirely satisfying and one of us (J.C.C.), stirred by the suggestion in a recent article (Caswell, *et al.*, 1958) that a staphylococcus once cast off its host might not retain its virulence, infected his own skin by rubbing a dried infected woollen thread onto a slightly scarified area thus producing a prompt reaction in the form of a furuncle.   He had, some years previously, developed a cellulitis of the finger on the day following the handling of a broken test tube containing cultures of staphylococci that had been drying out in a glass jar on a shelf for five years.   The unusual bacteriophage type of the culture and of the infection left little doubt as to the source of the latter.   Thus we have reason to suspect that the staphylococcus maintains its virulence for a long time even under adverse conditions.

(*c*)   Though it be accepted that an infected patient will contaminate his surroundings and that his cast-off organisms maintain their virulence, proof is still lacking that these organisms in the dust will cause infection in patients who become exposed to them.   It remains for someone

145

deliberately to place a group of hospital patients known to be free of staphylococci into an environment grossly contaminated with an identifiable type of organism and to see if more infection develops in this group than in a similar group housed in a clean area. Our desire to prove the point has not been so great as to drive us to this extreme. We are satisfied to accept the probability that patients can become infected from their surroundings and that direct inoculation from person to person is not necessary to bring about an infection. The only evidence that we have that bears on this point is of an epidemiological nature concerned not only with patients in hospital but with the spread of staphylococcal infection in the families of patients discharged from hospital. These observations lend support to the theory that contaminated fomites can give rise to infection. One further piece of evidence is of an indirect type and has to do with the increased rate of staphylococcal wound infection in patients shown to have staphylococci in their skin at some time prior to operation. Table II shows that in patients with positive skin cultures prior to operation, the rate of wound infection is approximately five times as high as in those with negative cultures.* If it is accepted that a patient occupying a bed contaminated with staphylococci will, before long, start to carry some of these organisms on his skin, the above evidence is of some importance and the case for reducing contamination to a minimum in the wards is strengthened.

TABLE II

SHOWING THE INCIDENCE OF STAPHYLOCOCCAL WOUND SEPSIS IN PATIENTS WITH POSITIVE AND NEGATIVE SKIN CULTURES PRE-OPERATIVELY.

Pre-operative skin culture	Subsequent wound sepsis	
Skin positive 41	11	26·8%
Skin negative 356	21	5·9%

(d) Critics of an isolation unit have suggested that not only does such a unit disrupt the smooth running of a surgical or medical service, but that it actually increases the risk to the patients and to their attendants. Since the establishment of our unit some four years ago, we have gained sufficient experience to be able to state unequivocally that this is not the case. In fact the reverse holds true, for the careful techniques developed in this specialized unit have resulted in a lower incidence of staphylococcal infections in its nurses and orderlies than prevails elsewhere in the hospital and re-infection and new infections in patients admitted to the unit have been infrequent. There is no doubt that to transfer a patient from an

* These figures were submitted to Mr. G. Renwick, Statistician to Department of Health and Welfare of B.C. who states that by both a standard error of the difference between two proportions and the Chi square tests the difference in the rate of infection in those who showed positive skin cultures was significantly higher than in those who did not.

ordinary ward to an infection unit is disturbing to both patient and doctor
—the former senses that something has gone wrong and the latter may be
embarrassed—nevertheless, we feel that the advantages far outweigh
these unfortunate features.

The next question and the real crux of the situation is whether the
programme is effective in reducing the incidence of infection. To answer it
with assurance, it would be necessary to compare the rates of infection
before and after the introduction of the plan and the system of case finding
and recording should be accurate and uniform throughout. Furthermore,

RECORD OF N 2 STAPH. INFECTIONS TAKEN FROM
DRESSING ROOM BOOK
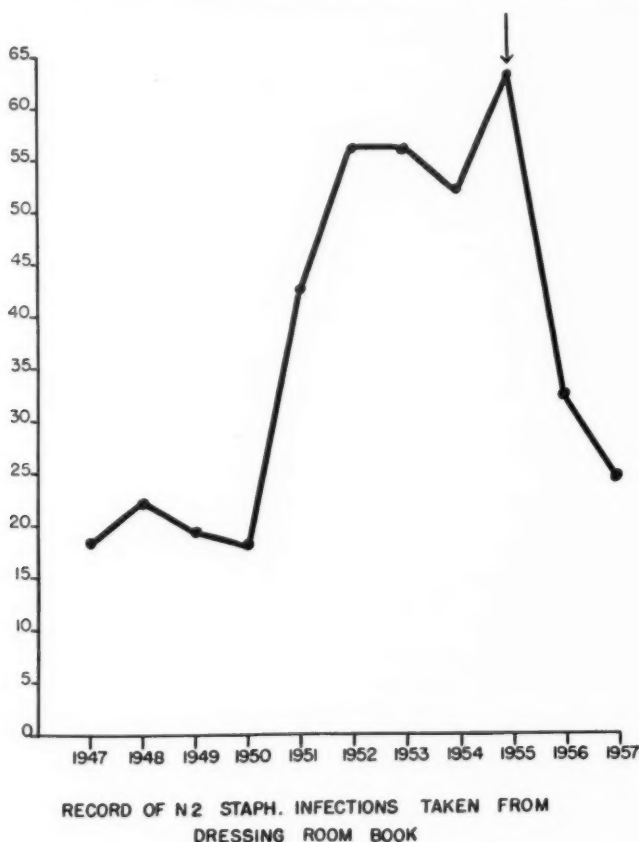
Fig. 2. Indicating the number of staphylococcal wound infections occurring in a
general surgical ward each year from 1947 to 1957. The arrow indicates the point at
which an intensive programme of control was introduced.

147

12

the essential personnel involved in the care of the patients should remain the same. We can produce a chart (Fig. 2) which indicates that the number of staphylococcal wound infections, which had risen sharply in 1950 to a high level where it remained until 1955, dropped in a most encouraging way after we had put our plan into effect. But we would hasten to point out that these figures—convenient though they may be to our purpose—should be used cautiously in argument concerning the merits of the measures taken for it might well be that other factors particularly the personnel involved in the care of the patients on the ward have been of vital importance. It is a matter of some regret to us that we have, in fact, no comparable estimate of the results prior to the introduction of the plan. All that we can claim is an accurate record of the infections in a general surgical ward of sixty-five beds during the two and a half years since the plan in its entirety was introduced and those figures can only be used as a baseline for future reference, for it is impossible to determine their absolute value and difficult to compare them with the reports of others owing to the varying techniques used in collecting and classifying cases of infection.

Case finding

In order to avoid missing cases of infection, we have found it necessary to go beyond the ordinary recordings that are made at the time of physical examination, ward rounds and dressings for frequently at these times other features of the patient's condition are more impressive and careful observation of the wound may be omitted. One of us (W. H. S.) has conducted a regular ward round each week for no other purpose than to search for infections. At this time the patient's whole body surface and the wound are carefully examined and cultures are taken of any suspicious lesions if this has not already been done. The vast majority of patients return to the Outpatient Department following their discharge from hospital and here an occasional case of late developing infection is picked up.

Definition of infection

We classify as infected any wound which shows clinical evidence of infection, no matter how slight, or any wound which discharges fluid containing bacteria of any type. Thus, for example, we include as infections cases showing as little as a small zone of redness around a stitch and cases where the discharge coming from a drained wound contains bacteria even though there is no other evidence of sepsis.

In order to provide a clearer picture of the problem we have classified the infections into four grades according to their severity as follows :

Grade I   Minimal infection. Redness about a stitch.

Grade II   Pustules about a stitch. Minor infection of wound edges without separation. No systemic reaction.

Grade III   Frank infection of a relatively small portion of a wound with purulent discharge. Possibly some systemic reaction.

Grade IV   Frank infection of a large portion of the wound usually
                with systemic reaction.

Obviously, not all cases can be classified accurately, but we believe that
such a subdivision has some merit. For the purpose of this presentation
we have grouped together grades III and IV and called them clinically
significant infections because by and large they have affected the patient's
course—sometimes seriously.   We have regarded Grades I and II as
insignificant from the patient's point of view.

Type of cases studied

The patients have all been males and for the most part they have been
elderly. The average length of stay in the ward—a potentially important
factor in hospital infection—has been long (approximately twenty-five
days). We have made no distinction between clean, " potentially infected "
or " dirty " cases and as Table III indicates the proportion of cases that
might have been excluded had this differentiation been attempted is
quite high.

TABLE III
SHOWING THE TYPES OF OPERATIONS PERFORMED DURING THE PERIOD OF OBSERVATION
WITH THE APPROXIMATE DISTRIBUTION

	Per cent.
Oesophagus and stomach	12·0
Biliary	6·0
Large intestine	5·0
Abdominoperineal	1·0
Small intestine and appendix	9·5
Pneumonectomy, lobectomy, etc.	3·0
Head and neck	3·0
Sympathectomy	3·0
Vascular grafts	1·5
Varicose veins	9·5
Amputation	4·0
Hernia	19·0
Miscellaneous—Major	3·0
Minor	20·5

We adopted these somewhat stringent criteria because it seemed that
to call everything a wound infection that might possibly be so called
and to include all cases in whom an incision was made would eliminate
some of the inaccuracies that are bound to creep in if the investigator is
permitted to make too many arbitrary decisions.

In calculating the incidence of wound infection, no account has been
taken of the number of incisions. While many operations require multiple
incisions (e.g. abdominoperineal resection with the laparotomy, the
colostomy and the perineal wounds) we have preferred to count each case
as one and to record it as an infected case if sepsis occurs in any of the
wounds. The only exceptions to this rule have been the eighty-four cases
where varicose veins operations were carried out simultaneously on two
extremities. In these instances each extremity has been counted as a case.

Figure 3 shows our experience with wound infections of all types
during the period from October 1955 to the end of February 1958. Each

149
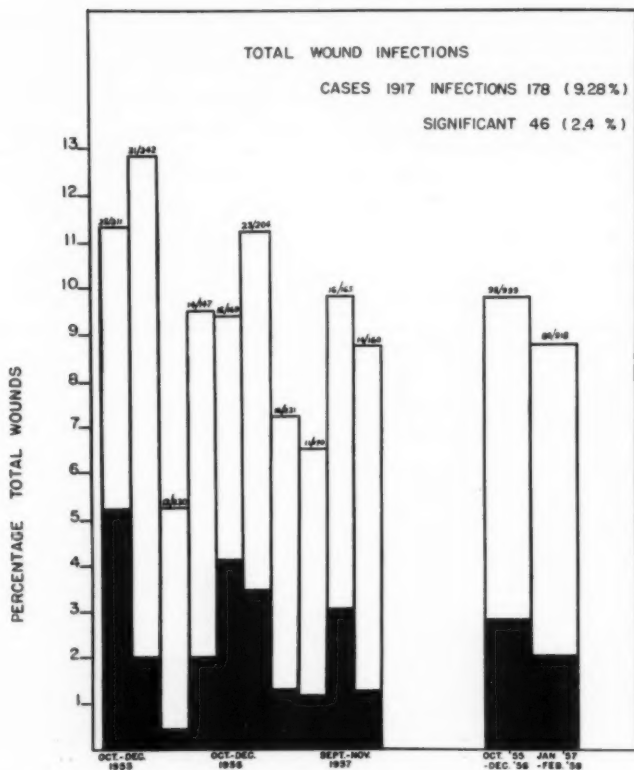
Fig. 3.   Wound infections of all types encountered October 1955 to February 1958
expressed as percentage of cases undergoing operation.
Each narrow block on the left of the figure represents the sum of infections in a
twelve-week period.
The two wider blocks on the right of the figure show the infection rates in the first
and second halves of the period of observation.
The dark portion in each block indicates the clinically significant infections. The
upper light portion indicates the trivial infections.
The figures above each block indicate the number of infections and the number of
cases operated upon during that period.

block shows the percentage of wounds which became infected during a
twelve-week period. Of the 1,917 cases operated upon during this period
178 (or 9.28 per cent.) developed some degree of infection. Roughly
one quarter of these infections was regarded as clinically significant—
the actual rate of significant infection over the whole period being 2.4 per
cent. of all wounds.

150

In order to determine whether or not there was any improvement in our results during this period, we divided it into two equal parts as shown in the wider blocks on the right in Figure 3. We found that there was a disappointingly small and probably insignificant drop from 9.8 per cent. to 8.7 per cent. for the total infections and from 2.8 per cent. to 2.0 per cent. in the clinically significant infections.

Turning to Figure 4, we see that the staphylococcus is present in well over one third of our infected cases and that it causes nearly four-fifths of our clinically significant infections. The fluctuations in the rate of staphylococcal infections parallel very closely those for the whole group
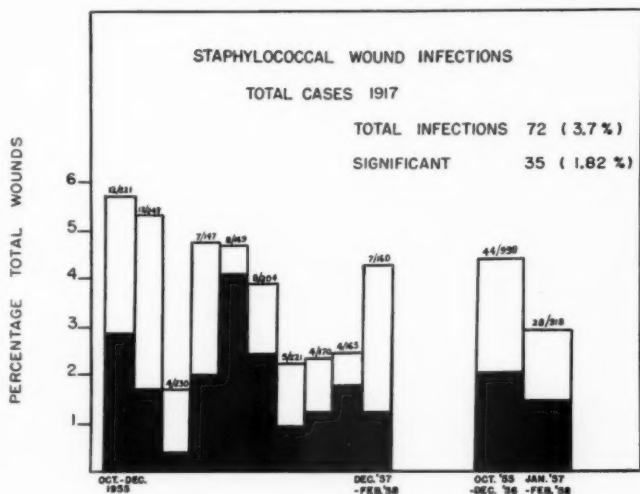
Fig. 4. Staphylococcal wound infections encountered October 1955 to February 1958 expressed as percentage of cases undergoing operation.

Each narrow block on the left of the figure represents the sum of staphylococcal infections in a twelve-week period.

The two wider blocks on the right of the figure show the staphylococcal infection rates in the first and second halves of the period of observation.

The dark portion in each block indicates the clinically significant infections and the upper light portion the trivial infections.

The figures above each block indicate the number of infections and the number of cases operated upon during the period.

and by the same token the slight decrease in the second half is to be seen and its slightness is to be regretted ; for we had hoped that even though our basic technique remained the same throughout, there would be progressive and marked improvement.

In addition to recording the wound infections, we have noted the incidence of other types of infections—boils, pneumonia, &c. Whereas in

the past these infections assumed serious proportions at times, they have been rarely seen in the last two years and there have been no deaths from infection acquired in hospital.

It remains now for us to determine whether this fairly constant rate of wound infection that we have achieved is good or bad. On this point we falter for it is difficult to find a standard against which to match our results.

Meleney, years ago, suggested that there must be an irreducible minimum infection rate, but at a time (in 1935) when his reported rate was half our present rate he made no claims to have reached this minimum.

In Table IV are summarized the results of some of the reported series. Theodor Kocher's remarkable series (1899), reported only thirty-two years after Lister's original paper on the Antiseptic Principle in the Treatment of Compound Fractures, is the earliest record that we have encountered of the incidence of infection in a sizeable group of cases covering a wide range of surgical conditions. It is of some interest to note that in four out of the five cultures that he made in his eight infected cases a staphylococcus aureus was recovered.

TABLE IV

Author	Year	No. of wounds	Type of case	Infection		Total
				Serious	Trivial	
				%	%	%
T. Kocher ..	1899	325	All	2·3	—	—
F. Meleney..	1933	1,132	95% Clean	1·1	3·6	4·8
F. Meleney..	1939	2,591	66% Clean	—	—	3·3
R. Shooter	1954–55	959	Clean	—	—	9→1
C. Howe ..	1956	1,157	All	2·67	—	—
S. Clarke ..	1957	382	All	6·5	7·1	13·6
J. S. Jeffrey	1957	673	All	9·8	16·3	26·1
Present series	1958	1,917	All	2·4	6·9	9·3

Meleney's classic work in the pre-war period sets the pace for the modern era. There is every evidence that his methods of case finding and classification of infection were above reproach and one can only marvel at the technical efficiency that must have prevailed in his hospital at this time. It would indeed be interesting to know if this record has been continued since the advent of the antibiotics and the evolution of what some believe to be a particularly virulent type of staphylococcus. If it has been maintained, our question as to whether our record is good or bad is plainly answered.

Shooter's report (Shooter, et al. 1,956), in which he describes a great reduction in the incidence of infections on a surgical ward following the correction of a fault in the ventilating system in the operating theatres close by, indicates the importance of aerial contamination, of ventilation and, incidentally, we believe, of maintaining the most strict techniques in all parts of the hospital.

Howe (1957) has performed a great service in his country by investigating the problem carefully in his hospital and writing forcefully on the subject describing the measures that he has adopted.

Clarke (1957) and Jeffrey (1958) have pointed out the gravity of the situation in their hospitals.

No purpose is served, however, by attempting to compare these figures for, in truth, as suggested earlier, they are not comparable. One may be certain that none of these authors is satisfied with his results—each will have fault to find with his own methods. We have, for instance, largely ignored the carriers, having believed until recently that there was no effective way of treating them and that because such a high proportion of the staff are carriers it would be impractical to remove them from contact with the patients. One of us has had considerable success recently in converting carriers to normal by the use of a programme consisting of a general decontamination of the patient's clothing and bedding, &c., plus the use of a Neomycin nasal spray and we are now encouraged to seek out carriers and to treat them. We think, too, that we may not have been energetic enough in preparing the patient's skin for operation and here we might well take a leaf out of the books of some of the older surgeons. Finally, we have toyed with the idea of irrigating our wounds with antiseptics, and we have experimental work showing that to irrigate with Hibitane a wound grossly contaminated with staphylococci markedly reduces the incidence of infection. We are not satisfied that this does not in some way affect wound healing and we have not yet tried it on patients.

I have no doubt that many other faults will be found as time goes on —but perhaps if we persist we shall come closer to that tantalizing and elusive " irreducible minimum."

One wonders what comments Lord Moynihan would have made if he had heard this presentation today. Certain it is that he was interested in wounds and in his earlier years as a student he must have taken some part in the controversies about Listerism that still raged in Britain in the '80s. Nor is there any doubt as to which side he would have supported, for his later writings on Lister radiate admiration. We know, too, that he was most meticulous in all technical matters and one gets a hint of his concern for the wound when, in his book on abdominal surgery (1906) he describes his preparation of the skin. For forty-eight hours prior to the operation the abdomen, which had been shaved and scrubbed, was covered with a compress saturated with strong antiseptics (1 per cent. formalin, 1 in 60 carbolic or 1 in 2,000 biniodide lotion) and this application was maintained until the time of operation. Nothing in his writings suggests that infection of the wound was a serious trouble to him. He would doubtless be somewhat surprised to find that this problem which had been solved during his lifetime should have recurred to plague later generations and if he were critical of our laxity in technique, we might find it difficult to make a strong reply. One suspects that he would have had little patience

with many of the measures that we have adopted and discussed to ay.
He would almost certainly have regarded isolation as unnecessary an he
would perhaps point out that Lister achieved his early successes in Glas ow
with his ward separated only by the width of a corridor from a unit hat
had to be closed down because of the death rate from infection, and hat
Lister's whole attention was directed to the care of the wound and the
objects with which it came into immediate contact.

Notwithstanding these strong arguments, we have come to the con-
clusion that the problem that exists today is unlikely to be controlled in
the long run by any attack that is not based upon the principle of pre-
venting contamination of the patient throughout his course in hospital.
Thorough preparation of the wound area and immaculate techniques in
the theatre and at the time of dressings will go a long way towards pro-
ducing clean wounds and no one would deny that these measures are of
paramount importance. We believe, however, that better results will
be obtained if the care that prevails at these critical moments is maintained
continuously.

Surely, we feel, to admit a patient to a ward that harbours a profusion
of pathogenic staphylococci—as it will unless special precautions are
taken—is to increase the possibility of sepsis developing in his wound.
And, even if this is not so—if wound sepsis can still be prevented—we
submit that most, if not all, of the measures that we have adopted are
clearly necessary to protect the patient from other forms of staphylococcal
hospital infection that can so frequently produce discomfort and
occasionally result in disaster.

REFERENCES

CASWELL, H. T., SCHRECK, K. M., et al. (1958) Surg. Gynec. Obstet. 106, 1-10.
CLARKE, S. K. R. (1957) Brit. J. Surg. 44, 592.
HOWE, C. (1957) Ann. Surg. 146, 384.
JEFFREY, J. S. (1958) Lancet 1, 365.
KOCHER, T. (1899) Trans. Amer. Surg. Ass. 17, 116.
MELENEY, F. L. (1935) Surg. Gynec. Obstet. 60, 264.
————————— (1941) Bull. N.Y. Acad. Med. 17, 221.
MOYNIHAN, B. G. A. (1906) Abdominal Operations. Philadelphia, W. B. Saunders,
    pp. 38-39.
ROBERTSON, H. ROCKE, COLBECK, J. C., and SOUTHERLAND, W. H. (1956) Amer. J. Surg.
    92, 233.
SHOOTER, R. A., TAYLOR, G. W., ELLIS, G., and ROSS, J. P. (1956) Surg. Gynec. Obstet.
    103, 257-262.

RECENT OVERSEAS VISITORS TO THE COLLEGE

RECENT OVERSEAS VISITORS to the College have included Professor Warren
H. Cole, of Chicago, and Dr. Charles R. Mayo, of Rochester, Minnesota,
both of whom received the Honorary Fellowship at the meeting of
Council on 10th July ; Dr. Willis J. Potts, of Chicago, who delivered a
Moynihan Lecture at the College in July ; and Professor I. S. Ravdin.
Hon. F.R.C.S., of Philadephia, Dr. Loyal Davis, Hon. F.R.C.S., of
Chicago, and Dr. Paul Hawley, Director of the American College of
Surgeons, who visited the College after attending the meeting of the
International Federation of Surgical Colleges in Stockholm.

CANCER OF THE ADRENAL CORTEX

The natural history, prognosis and treatment in a study of fifty-five cases

by

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Senior Surgical Registrar, The Royal Marsden Hospital, London

INTRODUCTION AND HISTORICAL ASPECTS

KNOWING OF JOHN HUNTER'S abundant interest in human and animal experiments it is surprising that no reference appears in his works to a study of the adrenal gland. Although Bartholomew Eustachius is credited with the first description of these as specific organs in man in 1563 their function was not understood until many years after Hunter's death when the clinical observations of Thomas Addison in 1855 were confirmed by Oliver and Schafer in 1895 with the demonstration of a pressor substance in the medulla. Cortical function was more elusive and although Hartman's extract in 1927 and that of Pfiffner and Swingle in 1929 indicated the role of the cortex in maintaining life, it is only since the isolation of cortisone from such extracts in 1936 almost simultaneously by Kendall in the United States and Reichstein in Switzerland, followed by its clinical application by Hench and his colleagues at the Mayo Clinic in 1949 that surgical interest in the cortex has been stimulated.

Secondary carcinoma involving the adrenal glands is frequently seen but primary carcinoma is rare and as the majority of published works refer to isolated case reports it has been felt justifiable to discuss the experience with this disease which has been obtained from a study of the case reports of fifty-five patients who have been mainly from the London teaching hospitals. All are histologically proven cases and in many of them the sections have been reviewed with Professor Cunningham of the Department of Pathology of the Royal College of Surgeons of England.

Experimental production of tumours

Adrenocortical tumours can be produced experimentally in animals by an alteration in the hormonal environment. Although it has not yet been shown that such changes take place in man, a consideration of the principles in animal experiments is worthwhile and may later lead to a solution of the problem.

Woolley and Little in 1945 were able to produce adrenocortical carcinoma in all cases of one strain of female mice by simple castration within one to three days of birth. These tumours appeared from the age

155

of six months onwards and similar lesions but with a slightly lower frequency were seen in male mice from the seventh month who had been similarly castrated at birth. No such lesions appeared in non-castrated animals of the same strain. Growth on transplantation with evidence of metastases in liver and lungs has been obtained, and Mulay and Eyestone (1955) have shown it may be associated with atrophy of the contralateral adrenal gland.

Prevention of these tumours is possible by the implantation of oestrogens and in some instances androgens. There is evidence in animals of a relationship between pituitary and adrenal tumours and Woolley (1950) found that in all cases where pituitary tumours were present there were well-developed adrenocortical ones, although not all animals with adrenal tumours had hypophyseal ones. Further, hypophysectomy prevents the anticipated development of adrenocortical carcinoma in castrated mice.

The explanation of these changes is not clear and so far there has been no known carcinogenic action of ACTH but the close relationship in animal work may be similarly important in man.

Basic considerations

For an adequate understanding of malignant adrenal tumours a brief reference to the anatomy and physiology of the gland is essential, but will here be restricted to its cortical portion. Such division into cortex and medulla exists only in mammals, where three distinct layers are recognised —the outer or zona glomerulosa, the middle or zona fasciculata, and the inner or zona reticularis. In embryos and during the first year of life the last named is of considerable size and accounts for the largeness of the gland at this time. In the newly-born, accessary adrenal glands are common and although disappearing with advancing years they have been found in association with almost every structure below the diaphragm and are important as occasional sites of tumour formation.

To appreciate the physiological properties of the adrenocortical hormones, necessary because of their excess in certain forms of tumour, mention must be made of their chemistry. All are organic compounds possessing the reduced cyclopentanophenanthrene nucleus, a class of substances which also includes cholesterol.

They may be classified into three main groups, and are for the most part under the control of the anterior pituitary. First, the glucocorticoids also known as the 17-hydroxycorticoids because of the presence of a hydroxyl group at the C 17 position (Fig. 1). Hydrocortisone and cortisone are the main members of this group. Second, aldosterone, first isolated in 1952 by Tait, Simpson and Grundy is a powerful salt retaining hormone which is only doubtfully influenced by the anterior pituitary. The third group are the sex hormones both androgens and oestrogens. The former are produced in greater amounts and may be measured both biologically and

chemically. The results of both bear a close correlation but the chemical method is simpler. It depends on the presence of a ketonic group at the C 17 position giving the name of 17-ketosteroids. Not all 17-ketosteroids have the same biological activity—e.g., oestrone—and some are biologically inert. In the normal estimation the phenolic group, such as oestrone, are removed and the neutral ketosteroids like androsterone are measured. A further division of the non-phenolic 17-ketosteroids into α- and β-groups occurs, about 20 per cent. of the total 17-ketosteroids being excreted in the β form. Dehydroepiandrosterone is the main adrenal androgen of the β type and high concentrations are found in some adrenocortical carcinomas.

CHEMICAL STRUCTURE OF IMPORTANT ADRENAL STEROIDS

Fig. 1.

157
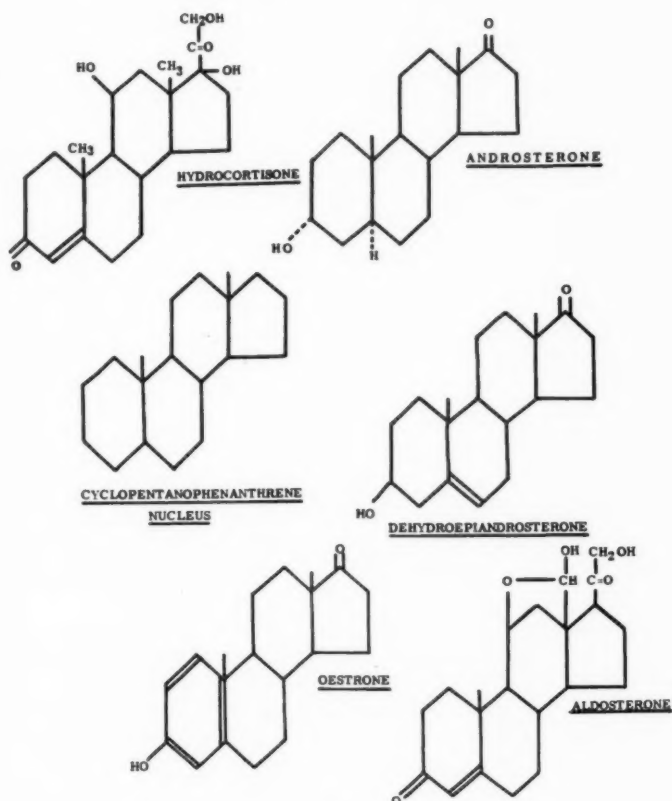
TUMOUR INCIDENCE

Types

It is most convenient to divide cortical tumours into those which produce hormones and those which do not. In future, and for simplicity, these will be referred to as hormonal and non-hormonal.

Frequency

An appreciation of the rarity of these tumours may be gauged by reference to the literature. Steiner (1954) reviewed all the necropsies at the Los Angeles County Hospital during the period 1918 to 1947 and found it accounted for 0.2 per cent. of all tumours, a total of fifteen cases. Wu (1940) found only eighty-two cases in the literature up to 1940. More recent reviews have included those of Rapaport, *et al.* (1952), who collected 238 hormonal and thirty-four non-hormonal tumours over a twenty-year period from 1930 to 1949, and Heinbecker, *et al.* (1957), reporting ten of their own cases, three of which were non-hormonal, and who added a further eighty-three from the literature, but no clear distinction was possible in the reviewed reports between benign and malignant lesions. Wood *et al.* (1957), in a recent paper on eight non-hormonal tumours, were able to find only twenty-seven cases in the European and American literature since 1923. In the present series of fifty-five primary carcinomas thirty-five were hormonal and twenty non-hormonal.

TABLE I

AGE INCIDENCE OF 55 CASES OF ADRENOCORTICAL CARCINOMA
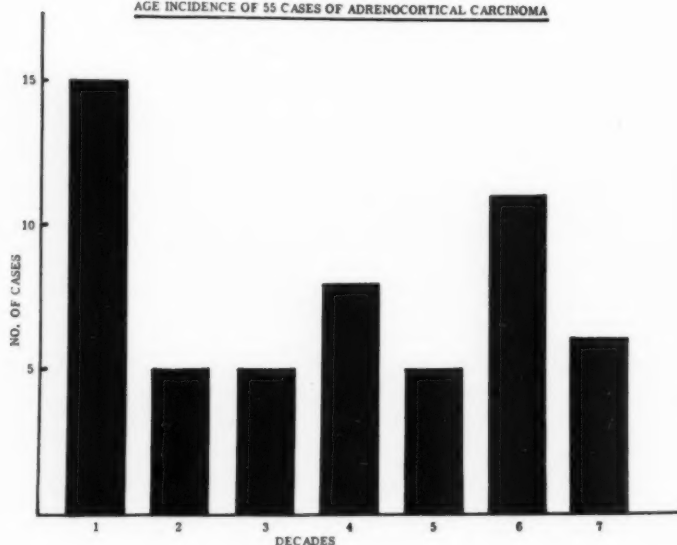
Age and sex

The age at diagnosis varied over the whole span of life ; the youngest being four and a half months, the oldest sixty-eight years with an average age of thirty-two years. Table I shows the incidence in decades, the number in children being strikingly high.

Further analysis of these figures and division into hormonal and non-hormonal tumours (Table II) indicates that 80 per cent. of the former group occur before the age of forty years whereas 65 per cent. of the latter group occur after fifty years. Two non-hormonal tumours were encountered before puberty and one at twenty-nine years, the remainder being in patients of more than thirty-eight years, that is, more in keeping with the

TABLE II

AGE INCIDENCE RELATED TO HORMONAL EFFECT IN 55 CASES

OF ADRENOCORTICAL CARCINOMA
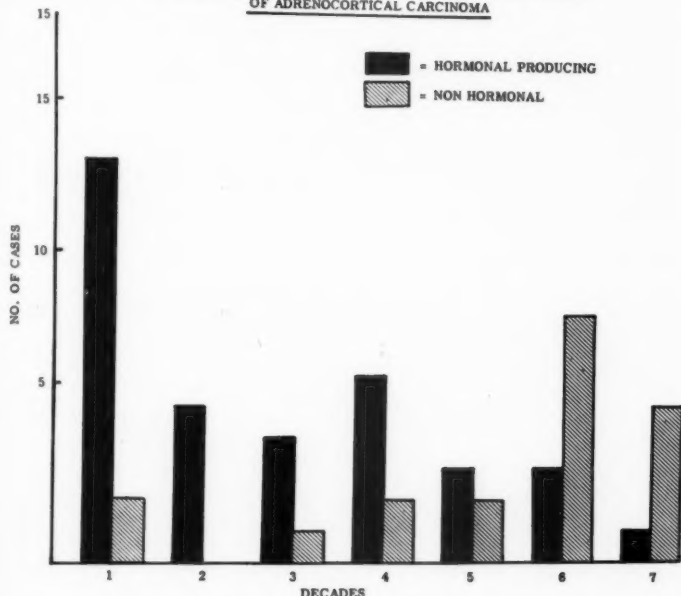
general cancer age incidence. Further illustration of the earlier age incidence of hormonal tumours is indicated by nearly 50 per cent. occurring before the age of puberty, the ratio to the non-hormonal type at this period being 8.5 : 1. After puberty this ratio alters to one of equal numbers, but with the emphasis in the younger adult of the hormonal type—61 per cent. under the age of forty years—and in the older adult of the non-hormonal type—65 per cent. over the age of fifty years.

159

In Table III the endocrine effects have been related to the age and sex. It is noted that there are very few hormonal tumours in older patients, and only three are post-menopausal. In the female these tumours are fairly evenly spread over their earlier age spectrum and are not pronounced at puberty or menopause, but in the male a marked preponderance is seen in the young. The high incidence of the non-hormonal tumours in the older group is apparent so that the male seems to be largely affected at one or other end of the age spectrum by tumours differing widely in their clinical manifestations.

TABLE III

RELATION OF ENDOCRINE EFFECTS TO AGE AND SEX IN FIFTY-FIVE CASES OF ADRENOCORTICAL CARCINOMA

Age in decades	Hormonal tumours			Non-hormonal tumours		
	Male	Female	Total	Male	Female	Total
0–10	6	7	13	1	1	2
11–20	2	3	5	0	0	0
21–30	0	4	4	1	0	1
31–40	1	5	6	2	0	2
41–50	0	3	3	1	1	2
51–60	1	2	3	5	3	8
Over 60	0	1	1	4	1	5
TOTAL	10	25	35	14	6	20

The overall sex ratio shows a preponderance in favour of the female of 1.3 : 1, but when the hormonal and non-hormonal types are considered separately some variation is found. In the former group the ratio is 2.5 : 1, which corresponds closely to the accepted figure in favour of the female, but in the non-hormonal type this ratio is reversed in favour of the male.

The site of the tumours in all cases was unilateral with a slight preponderance of left over right in about the proportion of 1.25 : 1 ; thirty-one tumours being on the left side, twenty-four being on the right.

PATHOLOGY

Macroscopic

The gross appearance of adrenocortical tumours varies considerably. Small tumours of 2 to 3cms. were found but the majority were of a large size, some reaching 20 to 30cms. in diameter, and weighing several thousand grammes. Spherical in shape, often with a lobulated surface, many are soft in consistency with a cut surface showing areas of necrosis and haemorrhage intersected by bands of fibrous tissue.

Histology

The microscopic diagnosis of malignancy in adrenocortical tumours presents certain difficulties. Criteria such as giant and bizarre nuclei

which in tumours elsewhere might suggest malignancy are found in lesions which may appear clinically benign. The presence of numerous mitoses, a large nucleo-cytoplasmic ratio, and marked pleomorphism are suggestive
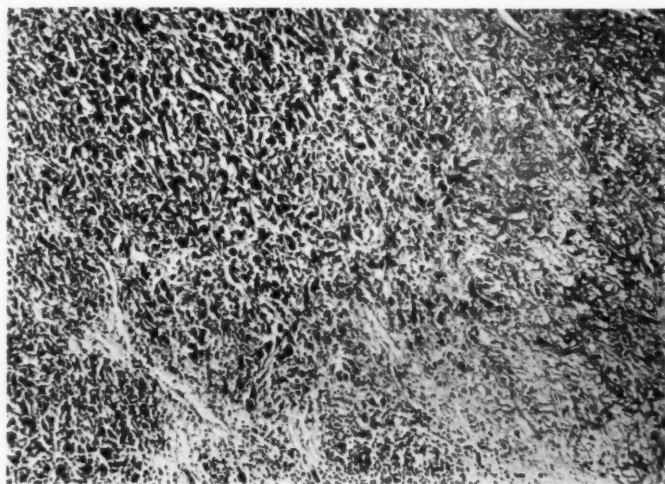
Fig. 2. Anaplastic adrenocortical carcinoma of non-hormonal type. × 80.
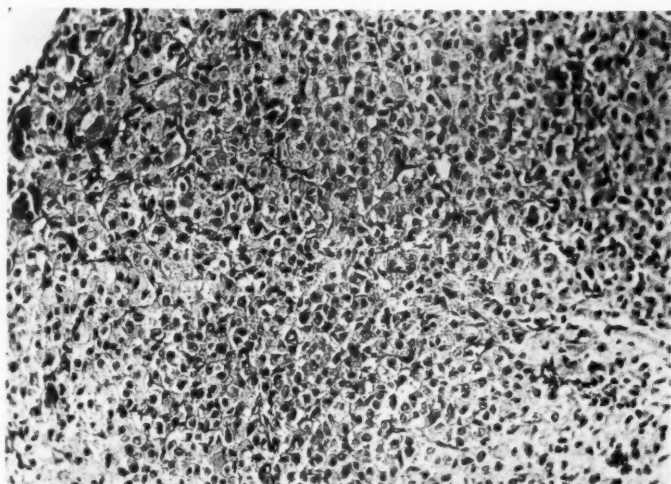
Fig. 3. Histologically benign appearance in non-hormonal adrenocortical carcinoma. × 80.

161

but not conclusive of malignancy. Whilst necrosis suggests malignancy much greater attention should be paid to mitoses which if frequent and abnormal should be regarded as diagnostic. Although these features
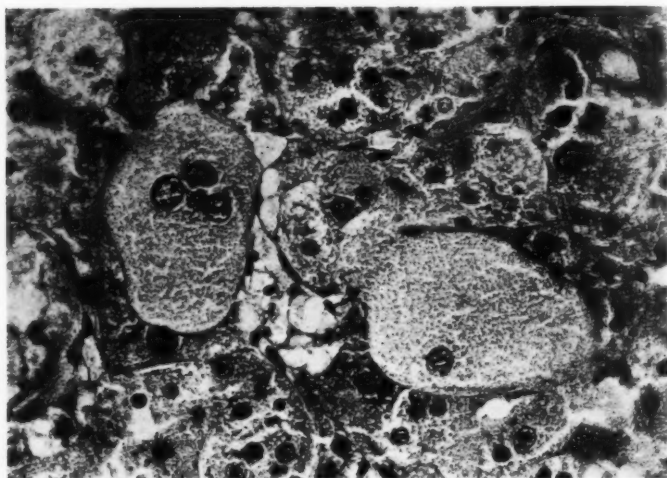
Fig. 4. Granular cytoplasm and moderate differentiation of cells in hormonal adrenocortical carcinoma. × 335.
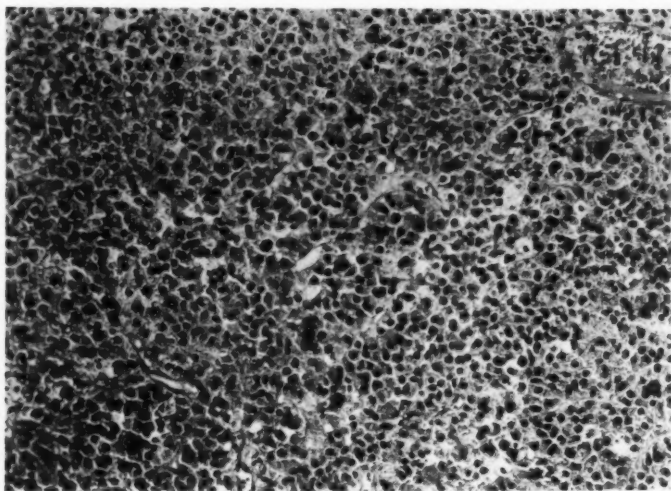
Fig. 5. Uniform compact cells in adrenocortical carcinoma. × 140.

suggest activity of the tumour, evidence of capsular infiltration or of invasion of venous or lymphatic channels are positive proof of the malignant potentialities of the growth.

Several types are noted. A very anaplastic form may be seen bearing little resemblance to the normal histology (Fig. 2). Others have a benign appearance, the cells closely resembling the normal (Fig. 3); that such a histological picture can be deceptive is shown by the fact that the tumour metastasized and the secondary growths had a histological structure in every way similar to that of the primary. Each of these cases was non-hormonal.

Although not always so, many tumours from hormonal cases contained cells which showed a moderate degree of differentiation and contained certain granules within their cytoplasm (Fig. 4). It would not seem unreasonable to assume that those cells were secreting hormones. A further difficulty arose in tumours composed of uniform compact cells seen in both hormonal and non-hormonal cases (Fig. 5). In such instances even special staining methods are of little use.

For a suggested explanation of this, the work of Symington *et al.* (1956) is important. Their experiments—based on the original concept by Yoffey and Baxter (1949)—have indicated that both glucocorticoids and the sex hormones may be produced in the zona reticularis. In stress, with ACTH stimulation, and more recently in Cushing's syndrome, they have shown an increase in the width of the zone of compact cells although the gland may appear macroscopically normal. Were this so in the present cases such proliferation of compact cells might be anticipated in a hormonally active gland but not in a non-hormonal one. It may well be that the compact cells from several tumours may appear identical when viewed by our present techniques but in fact a slight interference with the intermediate metabolism of the cell may result in hormone production in one case and failure in the other.

Whilst therefore the histological appearances are striking their interpretation is not possible in the present state of our knowledge. They must be taken in conjunction with the clinical picture and with the biochemical tests. The *in vitro* studies of Grant *et al.* (1957) following ACTH have borne close correlation with histology and might be applied in future to a study of tumours. It is only then that a reasonable and accurate diagnosis will be possible.

Spread

Extension of the tumour locally with involvement of the kidney, posterior abdominal wall, diaphragm, renal vein or inferior vena cava occurred in nearly one third of the cases (Table IV). Extirpation of the disease by radical dissection was contra-indicated in all but two of these because of metastases elsewhere, and in the two cases where still locally

13

TABLE IV
TUMOUR SPREAD IN FIFTY-FIVE CASES OF ADRENOCORTICAL CARCINOMA

				Number of patients	Percentage
Local invasion	..	..	..	17	30·9
Metastases	..	..	..	34	61·8

confined involvement of the aorta precluded resection. For surgical cure the diagnosis must be made early. Table V shows the sites and incidence of metastatic deposit. Blood and lymph borne spread occurred and the

TABLE V
METASTATIC SITES AND INCIDENCE IN THIRTY-FOUR CASES OF
ADRENOCORTICAL CARCINOMA

				Number of patients	Percentage
Local Lymph Nodes		..	..	15	44·1
Liver	..	..	..	23	67·6
Lungs	..	..	..	16	47·1
Bones	..	..	..	6	17·6
Other sites	..	..	..	11	32·4

high proportion of metastases confirms the degree of malignancy. It is surprising that the liver is more frequently involved than the lungs and the latter more than the local lymph nodes.

Course in the untreated case

Twenty of the patients in the series, of whom six were children, fell into this category and provide the basis of study of the natural course of the disease. Eleven out of the twenty patients had non-hormonal tumours and all of these were male, emphasizing the preponderance of this type of tumour in the male sex.

An appreciation of the malignancy of these tumours may be obtained from Table VI which shows the survival time after diagnosis. In almost all cases it is short, being on an average 2.9 months. It is more brief in the non-hormonal group where it is 2.2 months compared with 3.8 months in the hormonal type, suggesting that these tumours carry a more grave prognosis.

Table VII indicates the overall duration of the disease. In two cases this was thirteen years and twenty years but the vast difference from the remainder and the late alteration in symptoms which occurred in both are indicative of malignant change in a previously benign lesion. If these atypical cases are excluded the average overall duration of symptoms in the untreated cases is 13.2 months. The suggestion that the non-hormonal type may be more serious is supported by an overall duration of 10.8 months as compared with seventeen months in the hormonal group.

The apparently unfavourable prognosis may be considered in more detail. Eleven of the patients died within a year and the outlook with any

TABLE VI

SURVIVAL TIME AFTER DIAGNOSIS IN 20 UNTREATED
CASES OF ADRENOCORTICAL CARCINOMA

●●●●● NON HORMONAL

▬▬▬▬ HORMONAL
PRODUCING TUMOURS

AVERAGE SURVIVAL TIME

MONTHS

TOTAL   NON-   HORMONAL
HORMONAL

MONTHS
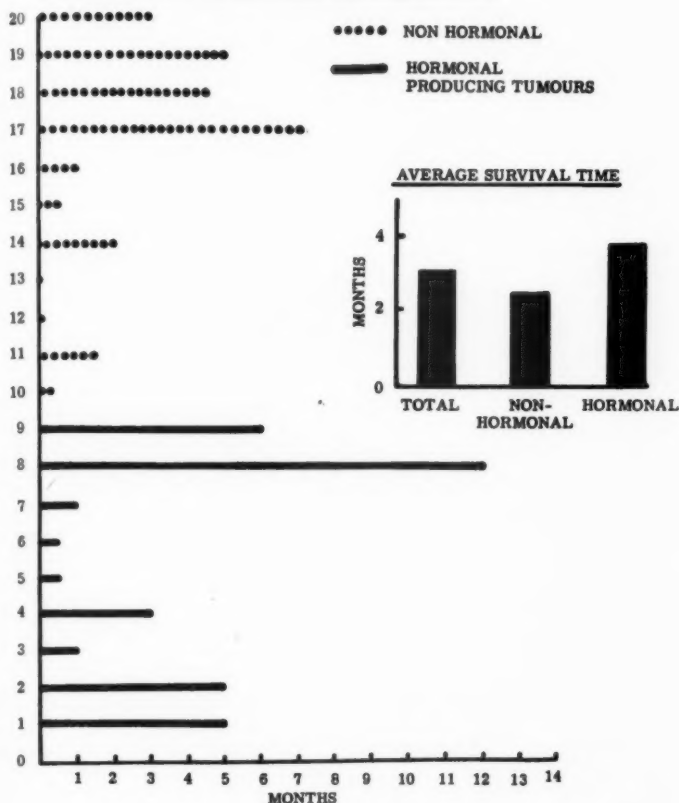
form of treatment might well be poor. Where the duration of the disease
was more than a year and particularly in the two cases with a long history,
salvage might have been possible. With earlier diagnosis in nearly half of
the patients in this untreated series an improvement in the prognosis
might have been obtained with surgical treatment.

Clinical

The non-hormonal tumours may present in a variety of ways, the
majority being recognized by pain or a mass in the loin or abdomen, or
by the presence of metastases. Haematuria where the kidney is invaded

165

13—2

TABLE VII

OVERALL DURATION IN 20 UNTREATED CASES OF ADRENOCORTICAL CARCINOMA

•••••••• = NON HORMONAL

━━━ = HORMONAL PRODUCING TUMOURS

AVERAGE OVERALL DURATION

MONTHS

TOTAL   NON-HORMONAL   HORMONAL

MONTHS
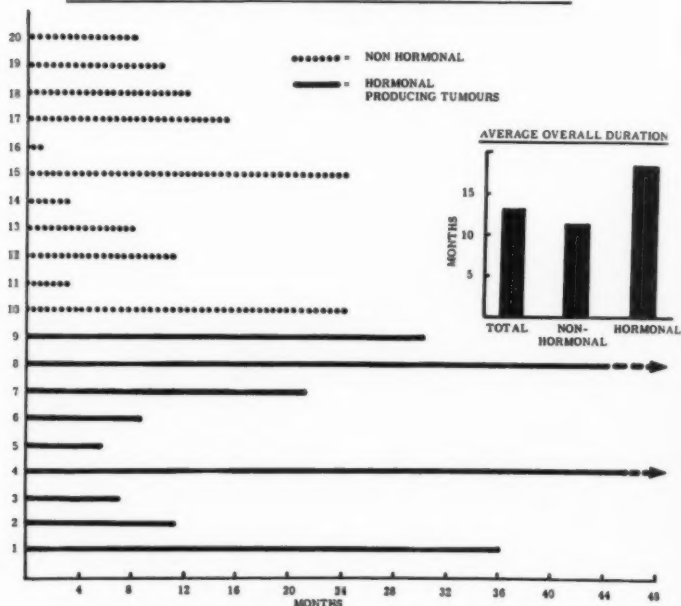
has suggested the diagnosis of carcinoma of this organ and one such mass in a child was thought to be a Wilms's tumour. The following histories are illustrative of this type of lesion.

(a) E.D.   Female patient, aged fifty-seven years, gave a history of an increasing painless abdominal swelling for one year. A firm, smooth mass was present in the left hypochondrium which was not tender and did not move on respiration. A plain radiograph of the abdomen confirmed the presence of a mass and showed areas of scattered calcification. A barium meal (Fig. 6) showed the stomach was displaced to the right, and a barium enema that the splenic flexure was displaced towards the pelvis (Fig. 7). No excretion from the left kidney was visible on intravenous pyelography and a retrograde pyelogram was unsatisfactory because the ureteric catheter could only be introduced half way along the left ureter. An aortogram revealed a vascular mass above the left kidney, and although the appearance was in keeping with a large renal tumour, the absence of arterial pattern of the kidney was suspicious of an adrenal lesion. At operation through a left oblique incision with removal of the twelfth rib an encapsulated mass twelve inches in diameter displacing the left kidney was removed.   Histology showed an adrenocortical carcinoma.   The patient remained well for five and a half years and then later developed extensive hepatic metastases.

(b) H.C. was a male patient of thirty-eight years who was admitted to hospital with a two-month history of malaise and weakness together with an unproductive

166

cough which had been present since an attack of " influenza." He had lost two stone in weight in two months and for one week had experienced pain in the upper part of the right side of his chest. There were no abnormal physical signs but a radiograph of the chest showed a rounded opacity in the right upper pulmonary zone (Fig. 8). A barium swallow showed a rounded mass projecting into the right lung field from the mediastinum. There was no response from radiotherapy and the patient died three months later. Necropsy revealed an unexpected anaplastic carcinoma of the right adrenal gland with pulmonary metastases.

(c) E.D., a housewife of fifty years, demonstrated the slow recurrence of some of these tumours and the value of further radical surgery. The history of pain in the right side with lassitude and loss of weight for three months together with a large mass in the right loin, and an intravenous pyelogram showing the right

Fig. 6. Gross displacement of stomach by adrenocortical carcinoma.

167

Fig. 7. Adrenocortical tumour causing marked colonic displacement.
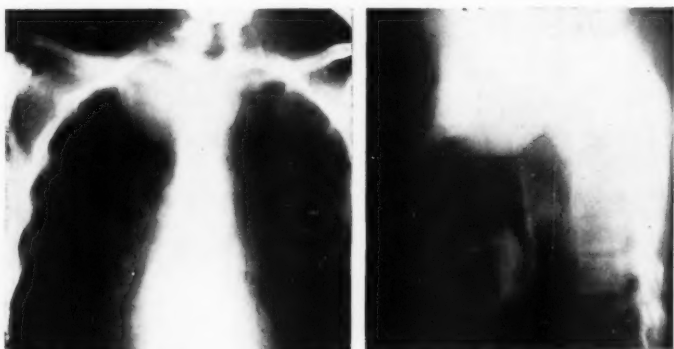
Fig. 8. Metastatic deposit from unsuspected primary adrenocortical tumour presenting as new growth of lung.

kidney being displaced to the pelvic brim all suggested a diagnosis of a renal neoplasm and the lesion was explored. A large tumour 32 × 30 × 12 cms. closely attached to the upper pole of the right kidney was removed together with the kidney. Histology did not reveal a highly malignant tumour. Two years later the patient was re-admitted with a large mobile mass in the right side of the abdomen and at laparotomy a tumour 19 × 12 × 11 cms. weighing 1,300 grammes was removed. Again the histology was not of high malignancy. Admission nine months later for another local recurrence which was this time invading the inferior vena cava allowed only partial removal of a growth of low malignancy. There was improvement for six months followed by further local recurrence, signs of anaemia, and inferior vena caval obstruction and death four years after the original treatment.

Wood *et al.* (1957), stress the importance of an intermittent low grade pyrexia associated with malaise and fatigue and when present this may be helpful in suggesting the diagnosis but it was not observed in more than two-thirds of the present series. In three cases it was thought to be a mild respiratory infection and not similar to a low grade renal infection.

An uncommon but important differential diagnosis is that of adrenal apoplexy. . Although the majority of these occur soon after birth when hypoprothrombinaemia and increased vascular fragility are pronounced, they may occur later and be confused with a neoplasm. The following case is illustrative of the findings :

Fig. 9.   Well marked adrenal haemorrhage in a child of six days with adrenal apoplexy.

169

R. D., a normal full-term male child weighing 11lbs. at birth made satisfactory progress until the sixth day when there was a sudden onset of pallor and vomiting necessitating blood transfusion. This was followed within twelve hours by a dull and non-shifting swelling in the right side of the abdomen. An intramuscular pyelogram revealed a distorted ureter on the right side. At laparotomy, adrenalectomy and nephrectomy were performed. The specimen (Fig. 9) showed histologically-marked adrenal haemorrhage with a surrounding zone of congested but otherwise normal adrenal cortex. A satisfactory recovery was made.

When the rapidity of the appearance of the mass associated with signs of adrenal insufficiency are considered, recognition that an adrenal or renal neoplasm is not present will result in the conservation of a healthy kidney.

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Fig. 10. Hirsutism and acne in a patient of twenty-two years with adrenogenital syndrome.
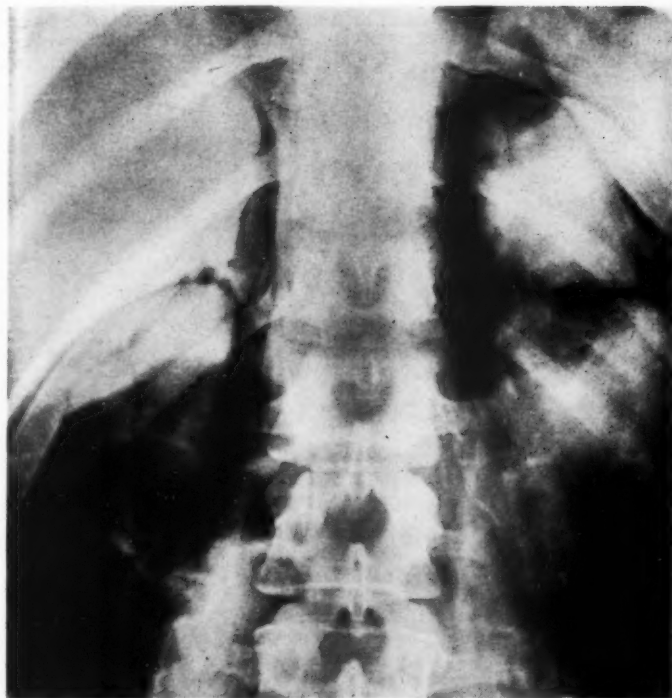
Fig. 11.   Adrenal tumour demonstrated by peri-renal insufflation.

Hormonal tumours are recognized by the clinical effects of the hormones produced.   The following are illustrative of the androgenic type :

(a) J. C., a young woman of twenty-two years, gave a history of four months hirsutism involving the upper lip and chin with male distribution on the abdomen. For the same period there had been an acneiform rash involving the front of the chest and an increase of two stone in weight.   There was three months' amenorrhoea.   On examination, she was a heavily built female of muscular type, with hirsutism and acne (Fig. 10), but no palpable abdominal mass. An intravenous pyelogram showed downward displacement of the left kidney, whilst peri-renal insufflation demonstrated a tumour (Fig. 11).   The total urinary 17-ketosteroids were 110 mgms. per twenty-four hours.   A large left adreno-cortical carcinoma was found on exploration, not all of which could be removed, and death occurred six weeks later from pulmonary metastases.

(b) R. W. was a boy of eleven years who gave a history of eight months' left-sided abdominal swelling, increase in weight, the appearance of pubic hair and an acneiform rash on his forehead.   In appearance he resembled a youth of eighteen years and there was a large tumour about the size of a football in the left side of his abdomen (Fig. 12).   A left varicocele was also present. An intravenous pyelogram showed no excretion of the left kidney which

appeared replaced by a large mass. A radiograph of the epiphyses reveal d a bone age of eighteen years, and in the chest pulmonary metastases were s en. No surgical treatment was of value and death occurred shortly afterwards.
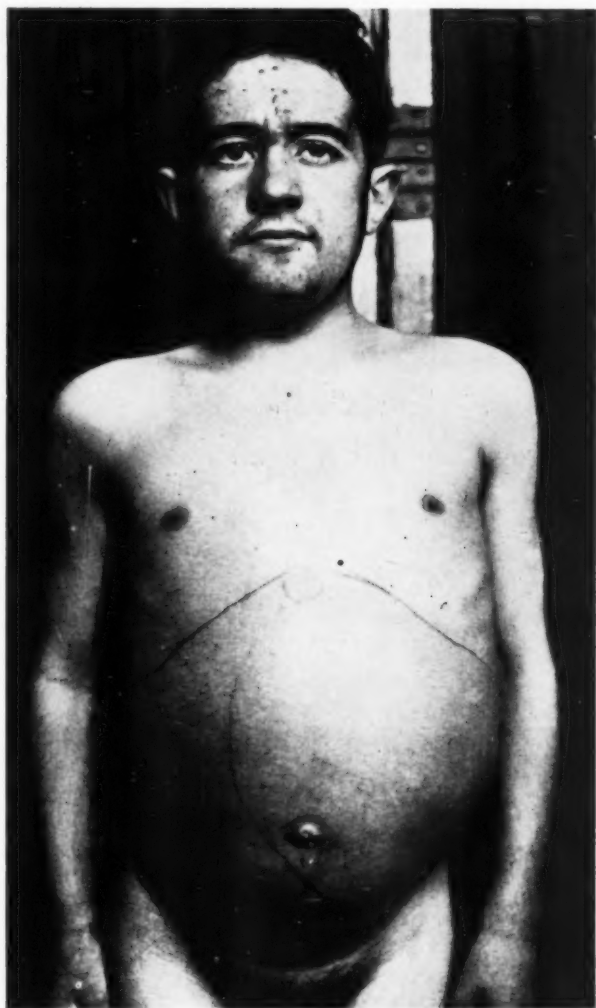
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Fig. 12. Gross abdominal swelling and secondary sex characteristics in a boy of eleven years with an adrenocortical tumour.

Necropsy showed an adrenocortical carcinoma of the left adrenal gland 10 × 11 × 8 inches invading and compressing the kidney with extension to the inferior vena cava, involvement of the para-aortic nodes and pulmonary and hepatic metastases.

(c) J. T., a six-year-old girl, was admitted with a two-year history of a growth of pubic hair, one year of deepened voice and six months of acne and hirsutism of face and axillae. She was a muscular child who appeared about nine years of age with a deep voice and marked hirsutism of face, arms and legs. In addition to the axillary and pubic hair there was marked enlargement of the clitoris (Fig. 13). Urinary 17-ketosteroids were 27.5 mgms. per twenty-four hours, and a radiograph of the hands revealed a bone age of ten to twelve years. Although an intravenous pyelogram was normal, peri-renal insufflation suggested a right-sided adrenal tumour. This was confirmed by exploration when a localized tumour 5 × 2 cms. was removed. An adrenocortical carcinoma with capsular invasion was found on histology. Four years later the patient was alive and well : the voice was less deep, the coarsened features and acne had disappeared although the pubic hair persisted : the urinary 17-ketosteroids were 3.0 mgms. per twenty-four hours.

Fig. 13. Gross enlargement of the clitoris and pubic hair in a girl of six years with an adrenocortical carcinoma.

The following are representative of the Cushing's type of presentation:

(a) S. P., a housewife aged forty-seven years, noticed that fifteen months before admission to hospital her face had become florid and for the previous twelve months there had been an increase in weight, sub-sternal pain on exertion and amenorrhoea. On examination, she was obese with a rounded florid face and a blood pressure of 240/130 mms. Hg. The obesity mainly affected the face, neck and trunk, the limbs appearing thin. The glucose tolerance curve was 88, 157, 230, 229 and 157 mgms. per cent. ; the B.M.R. +43 per cent. ; and the urinary 17-ketosteroids 42.5 mgms. per twenty-four hours. Radiographs of the skull, spine and chest were normal but downward displacement of the right kidney on intravenous pyelography was noted and peri-renal insufflation showed a circular shadow 5 cms. in diameter in the region of the right adrenal gland. A well-encapsulated right adrenocortical carcinoma was removed with a post-operative reduction of weight and return of normal menses. The blood pressure fell to 160/90 mms. Hg. and the urinary ketosteroids to 6 mgms. per twenty-four hours. Two years later there was a recurrence of her obesity and a further rise of 17-ketosteroids to 110 mgms. per twenty-four hours. Laparotomy revealed an irremovable tumour mass surrounding the inferior vena cava and death occurred three days later.

(b) S. A., a taxi-driver of fifty-five years was admitted in a state of hypertensive cardiac failure with a year's history of irritability, depression, headaches, and impaired concentration. One month before admission fullness of the face (Fig. 14) and an increase in abdominal girth had been noted. The obesity was confined to the face and trunk ; there were no striae. The blood pressure was 210/125 mms. Hg. An electrocardiogram revealed left ventricular strain. A radiograph of the vertebral bodies showed general decalcification and an intravenous pyelogram downward displacement of the left kidney with poor filling of the calyces. Urinary 17-hydroxycorticoids were 88 mgms. per twenty-four

Fig. 14. Facial appearance before and three months after surgery in a man of fifty-five years with Cushing's syndrome due to tumour.

hou s ; 17-ketosteroids 28 mgms. per twenty-four hours. There was no suppression with fluorohydrocortisone 25 mgms. per day for three days, or significant increase with ACTH 40 units b.d. for two days. At operation a large left-sided adrenocortical carcinoma was found adherent to aorta, diaphragm, pancreas and kidney. Tumour plus kidney were resected but a small portion adherent to the aorta could not be removed. Subsequently radiotherapy was given with slight improvement but hepatomegaly was noted four months later, and the patient died thirteen months post-operatively.

(c) R. P. was a boy of two years ten months admitted to hospital with increasing obesity and drowsiness for the previous five months. On examination a marked moon-shaped face and buffalo hump were present together with a blood pressure of 200/140 mms. Hg. Radiographs of skull and chest and an intravenous pyelogram were normal but urinary 17-ketosteroids and dehydroepiandrosterone were both raised. Cardiac failure developed and exploration of the adrenals performed. Both glands were normal but a primary adrenocortical carcinoma was found in a nodule near the left adrenal indicating carcinoma in an accessory gland. Death followed four days later and necropsy confirmed the findings.

No example of an oestrogen producing carcinoma was encountered, but thirty-four cases of this rare lesion have been collected from the world literature by Wallach *et al.* (1957), who report the most recent one. The main symptom is gynaecomastia which is present in more than half of the cases, but diminished libido, testicular atrophy and a thinning of the beard may occur. As in the present series a palpable mass has been found in 71 per cent. (Higgins *et al.*, 1956).

Foye and Feichtmeir (1955) report the only case of a malignant tumour producing aldosteronism. The clinical recognition is similar to Conn's syndrome with recurrent muscular weakness and transient paralysis, intermittent tetany and paraesthesiae, polyuria and polydypsia, accompanied by hypertension.

Distribution of clinical types

In the present series of hormonal tumours the androgenic type was most common, being three times as frequently seen as the Cushing's or mixed type (Table VIII). It is conceivable that the virilizing tumour is more easily recognized and that some of the other tumours masquerade as phaeochromocytomas or benign or malignant hypertension.

TABLE VIII

DISTRIBUTION OF SYNDROMES IN THIRTY-FIVE HORMONAL TUMOURS;

Clinical Type					Number of Cases
Virilism	..	..	..	..	22
Cushing's	..	..	..	..	7
Mixed	..	..	..	..	6

Duration in relation to sex and endocrine function

Table IX indicates the duration of symptoms in the two sexes. Accepting an arbitrary period of six months it is striking that in 57 per cent. of the cases, symptoms have been present for longer than six months. In three exceptional instances a history of twelve years, twelve years and nineteen

TABLE IX

RELATIVE DURATION WITH REGARD TO SEX INCIDENCE IN TREATED AND
UNTREATED CASES
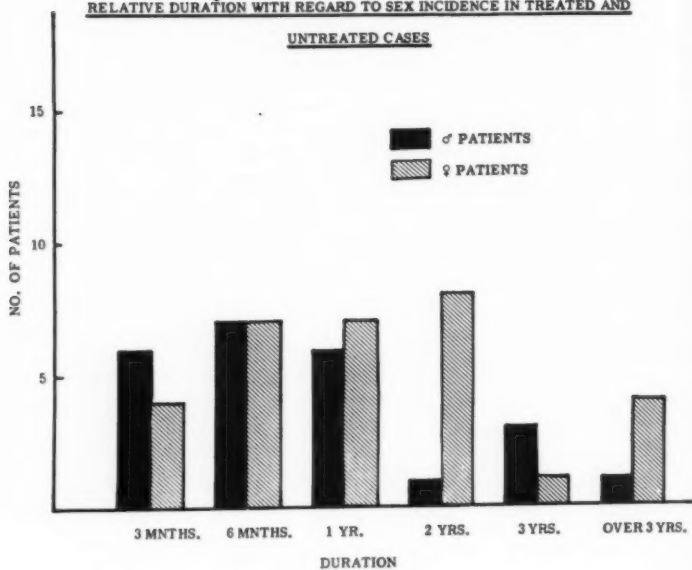
TABLE X

RELATIVE DURATION OF HORMONAL AND NON-HORMONAL TYPES IN TREATED
AND UNTREATED CASES.

176
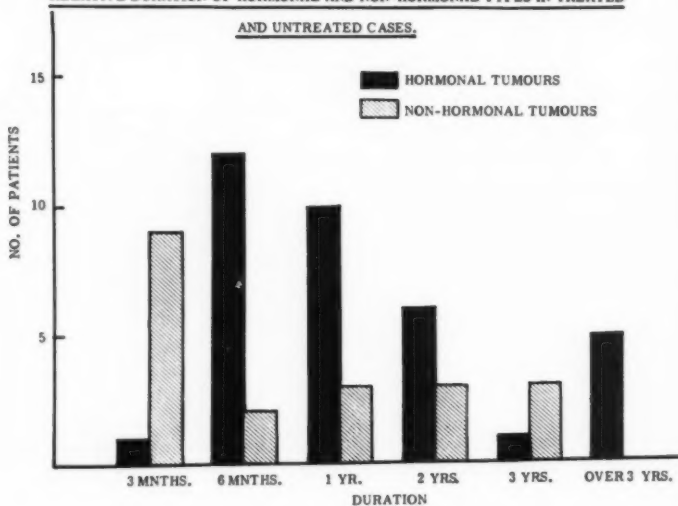
years respectively was noted and considerable variability exists so that many of the neoplasms are slowly growing, particularly in the case of the female patients.

Table X illustrates the influence of hormonal production on the duration of symptoms. In 45 per cent. of the non-hormonal group a very rapid history of less than three months is found and the combination of this with a male patient appears to indicate a bad prognosis. In 63 per cent. of the hormonal group a history of more than six months is found suggesting that with earlier diagnosis a more favourable prognosis may be obtained.

Relationship of a palpable mass to endocrine effect and duration

The presence of palpable mass in two-thirds of the patients indicates the importance of this sign of presentation (Table XI) more so in the non-hormonal group where there are no endocrine effects, and where it was found in 70 per cent. of cases. The size of the mass did not bear any relationship to the hormonal effects of the tumour either in their extent or their nature. The proportion of corticoid-producing tumours in which a mass was felt was lower than the other forms and the associated obesity of Cushing's syndrome might account for greater difficulty in palpation.

TABLE XI
RELATION OF A PALPABLE MASS TO ENDOCRINE EFFECTS

	Hormonal tumours	Non-hormonal tumours
Number of patients	35	20
Palpable mass	22 (62·8%)	14 (70%)
Androgen-producing with a mass	15 (68·0%)	Nil
Corticoid-producing with a mass	3 (40·8%)	Nil
Mixed type with a mass	6 (66·6%)	Nil

In 55 per cent. of the cases in which a mass was present there was a history of more than six months (Table XII) and the findings of a palpable mass does not necessarily indicate a very rapidly growing tumour. The close similarity of the curve representing those patients with a palpable lesion and the general trend of the disease denotes that the presence of such a mass does not indicate a worse prognosis.

The type of hormone produced in the presence of a palpable mass did not appear to influence the duration of symptoms.

Accessory investigations

These are of two main types, the laboratory estimations of a steroidal nature, and radiological examinations. Table XIII shows the steroidal studies which may be undertaken in adrenocortical carcinoma. These include the total 17-ketosteroids and 17-hydroxycorticoids in urine or less commonly in peripheral blood, and the fractionation of those steroids—still largely a research procedure. The main β ketosteroid, dehydro-epiandrosterone must be estimated and where applicable the oestrogen and

177

TABLE XII

INFLUENCE OF PALPABLE MASS ON DURATION OF DISEASE
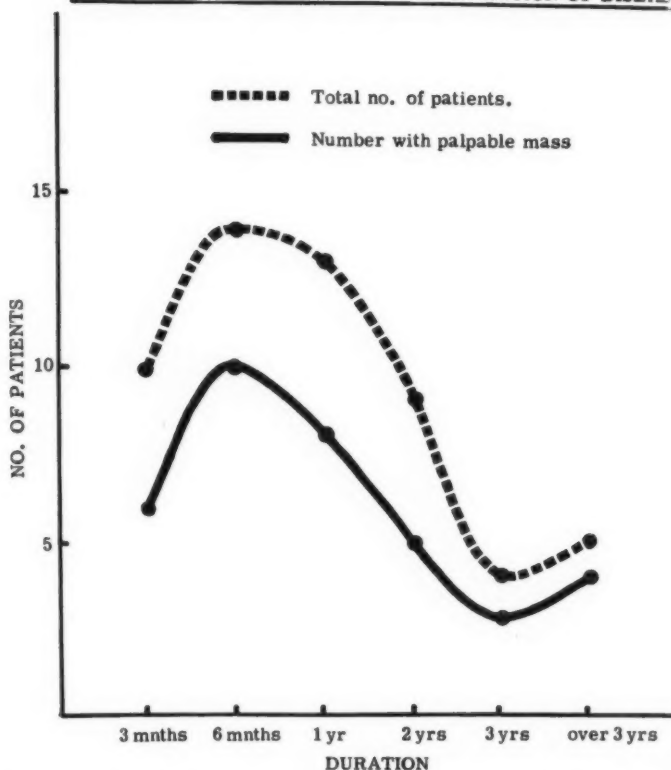
aldosterone levels. Blood obtained from the adrenal vein may contain 100 times the amount of hydrocortisone found in peripheral blood and cannulation of the main vein before excision of the tumour should be attempted. As the rate of flow may alter, e.g. with ACTH, the time must be noted and the measurement made in micrograms of steroid secreted per minute rather than per millilitre of blood. The steroidal studies should be completed by chromatographic estimations in the homogenized gland. Table XIV shows the radiological investigations which may aid the diagnosis. A plain radiograph of the abdomen may show a soft tissue mass or calcification in a tumour, whilst a radiograph of the spine may show decalcification in Cushing's syndrome. Radiography of the hands and wrists may indicate advanced bone age in a child with virilism and a film of the chest should be performed to exclude metastases. An

178

intra venous pyelogram must be done in all cases, and both a barium
meal and enema may on occasions give valuable information. Peri-renal
insufflation of air by the pre-sacral route aids in localizing the tumour
and in doubtful cases recourse to aortography may be fruitful.

TABLE XIII
STEROIDAL ACCESSORY INVESTIGATIONS OF VALUE IN ADRENOCORTICAL CARCINOMA
Total Urinary 17-Ketosteroids
Total Urinary 17-Hydroxycorticoids
Fractionated Steroidal Studies
Total Urinary Dehydroepiandrosterone
Total Urinary Oestrogens
Total Urinary Aldosterone
Peripheral Blood Studies
Adrenal Vein Cannulation Studies
Immediate Tumour Studies

TABLE XIV
RADIOLOGICAL ACCESSORY INVESTIGATIONS OF VALUE IN ADRENOCORTICAL CARCINOMA
Plain Radiograph of Abdomen
$\Big\{$ Hands
Plain Radiograph of Bones $\cdot$ Skull
$\Big\{$ Spine
Plain Radiograph of Chest
Intravenous Pyelogram
Barium Meal
Barium Enema
Peri-Renal Insufflation
Aortogram

In Table XV the findings in four of the more important steroidal and
radiological examinations are tabulated. The total urinary 17-ketosteroid
estimation was the commonest laboratory investigation in the series. Were
it not that some of the included cases were diagnosed nearly twenty years
ago it would have been employed more often. A gross elevation was
found in 81 per cent. of those investigated. Similarly, the Patterson test
showing a rise in dehydroepiandrosterone was positive in 75 per cent. but
the number in which it was estimated was not large (six) and its usefulness
would be better ascertained if it were more frequently undertaken. An
intravenous pyelogram gave a positive finding in 82 per cent. of the cases
in which it was employed although the adrenal was not always correctly
cited as the cause. Peri-renal insufflation justified its use in giving a 78 per
cent. positive result. The remaining investigations were not performed in
sufficient numbers to warrant their inclusion in this table but satisfactory
information was obtained including the two cases in which aortography
was used. The combination of the two simple tests of 17-ketosteroids and
intravenous pyelography gives a high proportion of positive results in the
androgen-producing tumour.

The degree of hormonal symptoms does not bear a constant relation
to the urinary ketosteroid output and although in general the larger
growths tend to produce the higher figures there are a number of excep-
tions. An increase above the normal level was noted in two clinically
non-hormonal tumours—68 and 40mgms. per twenty-four hours respec-
tively—further supporting the lack of correlation between the clinical

179

picture and the quantitative steroidal output. In general, the Patterson test was positive where there was a high level of alpha-ketosteroids. No correlation between the sex of the patient or the duration of symptoms and the steroidal output could be found and the highest figure recorded— 324 mgms. per twenty-four hours—was in a patient in whom the first signs of hormonal activity were noted in hospital.

TABLE XV

MAIN ACCESSORY INVESTIGATIONS IN 55 CASES OF

ADRENOCORTICAL CARCINOMA
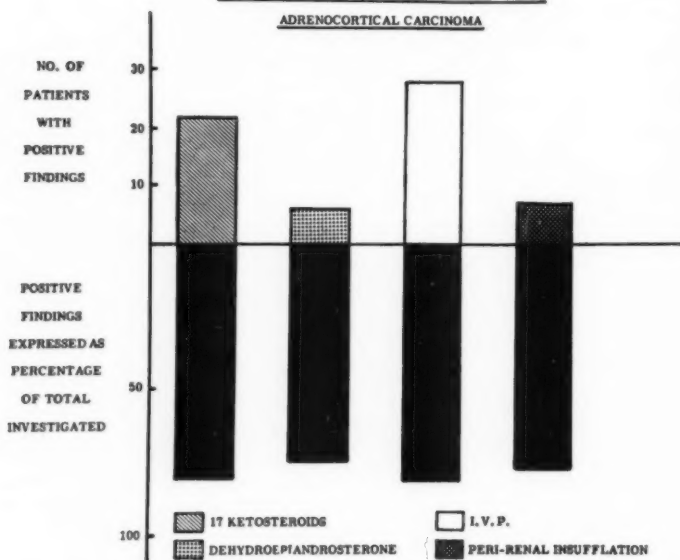
Although no great emphasis should be placed on an individual quantitative steroid estimation, a series is of considerable qualitative value. A fall to normal levels occurred after extirpation of the lesion, including the non-hormonal type, and its subsequent rise was indicative of the presence of metastases. Urinary steroidal studies may help to differentiate between cases of adrenal hyperplasia and of tumour. Harrison and Laidlaw (1953) have shown that following an eight-hour infusion of ACTH a marked rise occurs in hyperplasia but not in carcinoma where the tumour appears autonomous. Venning et al. (1952), similarly demonstrated a fall in the steroid level after cortisone suppression in hyperplasia, but no alteration in carcinoma. This lack of response was frequently demonstrated, but such autonomy was not complete in one case in the series—of Cushing's syndrome—already reported by Prunty (1956) where a rise in 17-ketosteroids and 17-hydroxycorticoids took place with ACTH, but there was

no till with cortisone suppression and both tests should therefore be performed.

Operative staging

Any satisfactory method of staging tumours is valuable in assessing prognosis, and, because of histological difficulties in interpretation, a clinical staging such as the T N M system attributed to Denoix and proposed at the International Congress of Radiology in Copenhagen in 1953 is more suitable. A modification of this classification so that an operative assessment may be made has been employed in this series. This allows the inclusion of a greater number of patients whose tumours were impalpable and an exact appreciation of the local spread. Table XVI illustrates such staging, which will be more accurate than clinical staging.

TABLE XVI
OPERATIVE STAGING OF ADRENAL TUMOUR

T   1. = Relatively Small Tumour—5cms. and under.
      2. = Relatively Large Tumour—over 5cms.
      3. = Infiltration locally reaching neighbouring organs.
      4. = Invasion of neighbouring organs—Kidney, Veins, etc.

N   (a) = No Nodes
      (b) = Mobile Nodes
      (c) = Fixed Nodes

M   Distant Metastases

STAGE I. = T1 Na
       II. = T2 Na
      III. = T3 Na, T1 Nb, T2 Nb
      IV. = T4, Nc or M contained in any combination

Forty-two tumours could be staged operatively, twenty-two being either Stage I or II and twenty in Stage III or IV—Table XVII. Eighty-two per cent. of the total hormonal tumours were operated upon and consequently staged, but only 65 per cent. of the non-hormonal reached surgery, the remainder being advanced growths or recognized only at post-mortem. Their failure to appear in Stage I is understandable when the anatomical position and lack of symptoms is considered. No statistical value could be placed on the operative staging of the tumours responsible for the various clinical hormonal syndromes.

In a condition of high malignancy it is reasonable to employ a three-year survival period in assessing prognosis. The thirteen survivors were found to be Stage I and II growths, that is where no infiltration has occurred. When extension locally or more distally has taken place the prognosis as measured by survival time is bad ; the average period after operation in Stage III being eight months, and in Stage IV, seven months.

The non-survivor in Stage I died after two years with metastases and it is doubtful if any further measure would have helped, but of the eight cases in Stage II who did not survive three years, six died within twenty-four hours of operation and a number of these deaths occurred at the

181

TABLE XVII

3 YEAR SURVIVAL PERIOD RELATED TO OPERATIVE STAGING IN 42 CASES
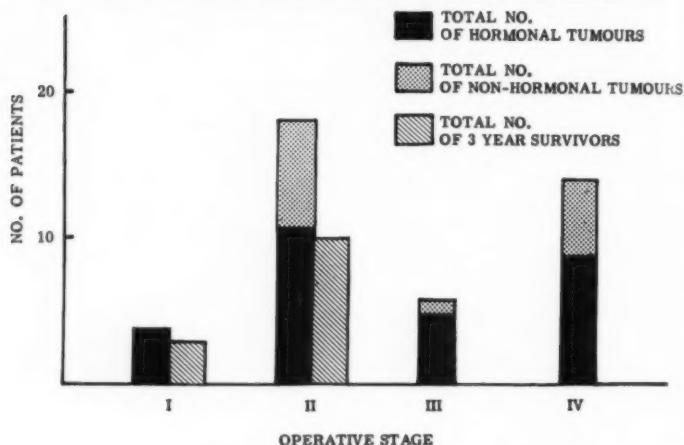
earlier period of the series, no doubt from electrolyte and hormonal imbalance associated with insufficiency of the other adrenal. Had this been corrected the number of three-year survivors in this group might have been higher. To better the prognosis earlier detection with a view to improving the Stage is important, but in fairness in a longer follow-up it has been found that one of the three-year survivors in Stage II has succumbed to the disease after four years, and another is dying from metastases after six years.

Prognosis from mortality results

To evaluate the prognosis from the mortality results it is first necessary to consider the nature of the surgery employed in the management of these cases. Although the number of three-year survivors—thirteen out of fifty-five—suggests a rather poor prognosis, analysis of the type of surgery performed emphasizes where improvement in prognosis could take place (Table XVIII). In 40 per cent. of all cases only laparotomy or palliative

TABLE XVIII
SURGICAL MANAGEMENT IN FIFTY-FIVE CASES OF ADRENOCORTICAL CARCINOMA

	Number of patients	Percentage
Three-year survivors	13	23·6
Surgery employed	42	76·5
Laparotomy	10	18·2
Palliative excision	12	21·8
Radical excision	20	36·4
Immediate mortality in forty-two surgical cases	11	26·2

182

excision was feasible, but in the twenty cases where a radical excision of the lesion was performed there were thirteen who survived for three years. Earlier diagnosis can be expected to increase the number of patients where such radical extirpation can be carried out.

The overall immediate mortality—deaths within one month of operation or in hospital—in the forty-two surgical patients is high and some improvement in prognosis would seem indicated. That this has occurred is seen by an analysis of the immediate mortality in the hormonal group of patients treated before cortisone became generally available and since (Table XIX). Reduction of immediate mortality in the non-hormonal group is likely with improved techniques which have taken place since some of the earlier cases. In the hormonal group the overall immediate mortality of 27.6 per cent. can be sub-divided into 35.3 per cent. before 1952 and 16.7 per cent. since. The advent of cortisone has thus more than halved the immediate mortality and greatly improved the prognosis in these tumours.

TABLE XIX

IMMEDIATE MORTALITY IN FORTY-TWO SURGICALLY TREATED CASES

	Number of patients	Percentage
Immediate mortality in thirteen non-hormonal cases	4	30·8
Immediate mortality in twenty-nine hormonal cases	8	27·6
Immediate mortality in seventeen hormonal cases before 1952 ..	6	35·3
Immediate mortality in twelve hormonal cases after 1952	2	16·7

Ten of the thirteen survivors are females (32.3 per cent. of the total number of female patients) and only three are males (12.5 per cent.), emphasizing the apparently worse outlook in the latter. Eight of the survivors had hormonal tumours, although only one of these was of the Cushing's type indicating the particularly bad outlook noted also by other authors (Heinbecker et al., 1957). There are five survivors in the non-hormonal group giving a slightly better survival rate than the hormonal type, which is at variance with the increased malignancy noted earlier. Further study of a greater number of these tumours is required to determine if in fact two distinct types of non-hormonal tumours exist.

Treatment

The method of choice is radical extirpation of the adrenal gland after adequate pre-operative preparation. Apart from the general care associated with any major procedure specific hormonal therapy is required. The excessive production of hormones by the hormonal tumours may result in atrophy of the contralateral gland. When the sole source of adrenocortical hormones in the body is then removed by excision of the tumour, collapse and death may follow, a feature of five cases in this

series—mainly occurring before its importance was recognized. In the prevention of this 100mgms. of cortisone should be given intramuscularly pre-operatively and 100mgms. of hydrocortisone intravenously during surgery. This should be followed post-operatively by cortisone for two weeks in a dosage which is gradually diminished to 50mgms. per day in the last three to four days and combined with an ACTH gel for this period.

Although removal of the tumour is the treatment of choice the exact extent of the operation has not been defined because of insufficient experience of any single surgeon. Where the lesion is localized to the gland total adrenalectomy on the affected side may be sufficient and was performed in ten out of the thirteen survivors. The study of the disease shows that spread takes place more frequently by the blood stream than by the lymphatics and thus block dissection of the lumbar nodes has a limited value. Nevertheless, in five cases these nodes were the only site of metastases and it would seem worthwhile to combine this procedure with tumour removal. Nephrectomy appears unnecessary unless the kidney is involved. Invasion of diaphragm or spleen would require their removal in an en-bloc dissection. No orthodoxy exists as to the type of incision but a thoraco-abdominal incision with resection of the eleventh rib and an extra-pleural dissection has much to commend it in allowing adequate exploration of the liver for metastases and sufficient room for en-bloc dissections.

Radiotherapy is not considered to be of great value but there was some temporary regression in two instances and further experience will show if there is some palliative value for the more anaplastic tumours with modern techniques. More recently chemotherapy in the form of amphenone has been tried in the control of inoperable hormonal-producing tumours with some temporary success (Thorn et al., 1956).

SUMMARY AND CONCLUSIONS

To recapitulate, a study of the natural history of this relatively uncommon condition has been presented in order that a better understanding of the normal process of the disease may be obtained and how it may be altered with modern treatment.

Emphasis has been laid on all aspects of diagnosis which will improve the prognosis by earlier detection. The clinical syndromes have been discussed and procrastination in their correct interpretation avoided by the maximum use of accessory investigations, the value of which has been recorded in the present series. Clinically difficult to stage, a modification of Denoix's classification has been suggested which can be utilized at operation and found to be of value in assessing prognosis. Where the tumour is confined locally the outlook is more hopeful but with spread to adjacent structures the prognosis is at once more grave, and survival time short.

Treatment of the disease must be directed towards early surgery, as other methods of radiotherapy and chemotherapy are unsatisfactory and should be reserved for palliation of the inoperable lesion. Adequate exposure is essential with full exploration of the peritoneal cavity to avoid unnecessary surgery and an extra-pleural thoraco-abdominal incision is recommended. In the absence of distant metastases unilateral adrenalectomy with local node dissection is advocated. Full steroid cover during and after surgery is vital in hormonal cases as death from contralateral adrenal atrophy is a grave hazard. The results of such treatment are more hopeful than is judged from individual case reports and have shown considerable improvement since the introduction of cortisone therapy.

Nevertheless, there are many factors about this disease that require elucidation. What is the relationship, if any, between adrenal hyperplasia, adenoma and carcinoma? Small cortical adenomas are common at necropsy and yet one meets few carcinomas. Adrenal hyperplasia is related in some instances to an increased output of ACTH yet it is doubtful if the pituitary bears responsibility in carcinomatous growths as for the most part, although not always, these tumours appear to be autonomous. Yet one cannot totally ignore that in animals malignant adrenal tumours which may be produced by castration can be prevented by hypophysectomy. Therefore it is essential that in the future management of these tumours greater emphasis must be laid on fuller steroidal studies of adrenocortical hormone production as measured at the time of surgery by adrenal vein cannulation. When circumstances permit, the intravenous administration of 25mgms. of ACTH in physiological saline during collection of the blood, with subsequent fractionation studies may clarify the issue of tumour autonomy. These findings must be correlated with the clinical and histological aspects and carefully documented. Only thus can a truly composite picture of these rare neoplasms be obtained with a subsequent lowering of their mortality.

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REFERENCES

ADDISON, T. (1855) *The constitutional and local effects of diseases of the Suprarenal Capsules.* London, Highley.
FOYE, L. V., jr., and FEICHTMEIR, T. V. (1955) *Amer. J. Med.* **19**, 966.
GRANT, J. K., SYMINGTON, T., and DUGUID, W. P. (1957) *J. clin. Endocr.* **17**, 933.
HARRISON, J. H., and LAIDLAW, J. C. (1953) *Surg. Forum,* **4**, 599.
HARTMAN, F. A., MACARTHUR, C. G., and HARTMAN, W. E. (1927) *Proc. Soc. exp. Biol. (N.Y.)* **25**, 69.
HEINBECKER, P., O'NEAL, L. W., and ACKERMAN, L. V. (1957) *Surg. Gynec. Obstet.* **105**, 21.
HENCH, P. S., KENDALL, E. C., SLOCUMB, C. H., and POLLEY, H. F. (1949) *Proc. Mayo Clin.* **24**, 181.
HIGGINS, G. A., BROWNLEE, W. E., and MANTZ, F. A., jr. (1956) *Amer. Surg.* **22**, 56.
KENDALL, E. C., MASON, H. L., and MYERS, C. S. (1936) *Proc. Mayo Clin.* **11**, 351.
——————— (1949) *Ann. N.Y. Acad. Sci.* **50**, 540.
MULAY, A. S., and EYESTONE, W. H. (1955) *J. nat. Cancer Inst.* **16**, 723.
OLIVER, G., and SCHAFER, A. E. (1895) *J. Physiol.* **18**, 230.
PFIFFNER, J. J., and SWINGLE, W. W. (1929) *Anat. Rec.* **44**, 225.
Proceedings of the Seventh International Congress of Radiology, Copenhagen 1953. Report on stage grouping and presentation of results of treatment of cancer. (1954) *Acta radiol., Stockh. Supp.* **116**, 713.
PRUNTY, F. T. G. (1956) *Brit. med. J.* **2**, 673.
RAPAPORT, E., GOLDBERG, M. B., GORDAN, G. S., and HINMAN, F., jr. (1952) *Postgrad. Med.* **2**, 325.
REICHSTEIN, T. (1936) *Helvet. chim. Acta* **19**, 1107.
STEINER, P. E. (1954) *Cancer, Race and Geography.* Baltimore, Williams and Wilkins.
SYMINGTON, T., DUGUID, W. P., and DAVIDSON, J. N. (1956) *J. clin. Endocr.* **16**, 580.
TAIT, J. F., SIMPSON, S. A., and GRUNDY, H. M. (1952) *Lancet* **1**, 122.
THORN, G. W., RENOLD, A. E., GOLDFEIN, A., NELSON, D. H., REDDY, W. J., and HERTZ, R. (1956) *New Engl. J. Med.* **254**, 547.
VENNING, E. H., PATTEE, C. J., MCCALL, F., and BROWNE, J. S. L. (1952) *J. clin. Endocr.* **12**, 1409.
WALLACH, S., BROWN, H., ENGLERT, E., jr., and EIK-NES, K. (1957) *J. clin. Endocr.* **17**, 945.
WOOD, K. F., LEES, F., and ROSENTHAL, F. D. (1957) *Brit. J. Surg.* **45**, 41.
WOOLLEY, G. W., and LITTLE, C. C. (1945) *Cancer Res.* **5**, 193.
——————— (1950) *Recent Progr. Hormone Res.* **5**, 383.
WU, S. O. (1940) *Chin. med. J.* supp. 3, 52.
YOFFEY, J. M., and BAXTER, J. S. (1949) *J. Anat. (Lond.)* **83**, 89.

THE MANAGEMENT OF THE APNOEIC PATIENT

by
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THE MANAGEMENT OF apnoea is really not the correct description of what I am going to talk about. Some problems of respiratory insufficiency would be nearer the mark ; but this of course includes the management of the patient with apnoea.

The commonest cause of apnoea in these days is general anaesthesia, but I am not going to refer to this induced apnoea at all. Nevertheless, it is because of our experience in maintaining apnoeic patients in controlled physiological balance in the operating theatre that we anaesthetists are vited to assist in the treatment of patients whose respiratory function las been disturbed or interrupted. The technique of controlled respiration in the theatre has been carried to the wards to control respiration which has become inadequate for the patient's safety or health.

It is necessary before considering this question of respiratory insufficiency to reflect for a moment on some aspects of respiratory physiology. I do not intend to go into it in any detail—you can read it, and should have read it many times, in Sampson-Wright's *Applied Physiology* or elsewhere, but I must refer you to the two main functions of external respiration ; oxygen intake and carbon dioxide elimination. Adequate oxygenation and adequate carbon dioxide elimination are not necessarily synonymous. You can have a pink patient but one suffering from respiratory acidosis ; for whereas oxygen intake depends upon the integrity of ventilation and diffusion, carbon dioxide, which diffuses twenty times more easily than oxygen, depends almost entirely upon ventilation for its elimination.

Oxygenation depends upon ventilation (i.e., the volume of air and the tension of oxygen in the air entering the lungs ; and its mixing evenly in the lungs) ; the ready diffusion of oxygen from alveoli to blood stream ; its carriage in the blood stream by the haemoglobin ; and the utilization of the oxygen by the cells of the various tissues and organs. The activity of the lungs, ventilation and diffusion, is called external respiration ; cell utilization is known as internal respiration. Respiratory insufficiency exists, as Woolmer has said, when external respiration fails to keep pace with internal respiration.

Control of ventilation depends upon four factors :

(1) Carbon dioxide tension in arterial blood (pCO_2).
(2) Oxygen tension in arterial blood (pO_2).
(3) pH of the blood.
(4) Pulmonary stretch receptors.

The first and the last of these are the more important, though in certain cases of carbon dioxide retention ventilation may depend almost entirely upon a lowered pO_2 for its driving stimulus.

Just as kidney efficiency can be measured by noting the volume and concentration of the urine, and estimating the urea and other substances in the blood, so pulmonary efficiency can be measured by recording tidal air, expiratory timed volume, and maximum breathing capacity as well as the analysis of alveolar carbon dioxide ; and blood gas analysis. The pO_2 and pCO_2 from samples of arterial blood can be estimated by a biochemical laboratory equipped for this sort of work. I must emphasize most strongly that diagnosis of respiratory insufficiency must, in the first place, be made on careful clinical assessment. Clinical judgment can be available much more speedily than laboratory reports, and time often matters a lot in the treatment of the sort of case we are going to consider.

What happens when respiratory insufficiency is present ?

Complete apnoea is, of course, not compatible with life for more than a few minutes. When ventilation and diffusion become inadequate, anoxia or hypoxia will occur, and carbon dioxide will accumulate in the blood. Anoxia in Haldane's classic phrase, not only stops the machine but wrecks the machinery. The cells most vulnerable to hypoxia are those of the cerebral cortex and irreparable damage can be speedily occasioned if hypoxia of any severity is allowed to continue beyond a very limited time. Carbon dioxide retention leads to respiratory acidosis, which in turn leads to medullary poisoning, establishing a vicious circle effect upon the respiratory control areas in the pons and medulla, a breakdown in renal compensatory mechanism and finally vascular changes, most importantly in the kidneys. All this is well known to you and is the ABC of respiratory physiology. Nevertheless, the results of respiratory insufficiency are so devastating, and again and again the implications inherent in the condition seem not to be realized by both doctors and nurses, that I make no apology for such elementary observations.

What causes respiratory insufficiency ?

Let us confine ourselves to patients breathing air at ordinary atmospheric pressure—leaving out, that is, the airman or mountaineer who may find himself in an environment deficient in oxygen.

The causes of respiratory insufficiency can be classified under five headings, and like most classifications this is an over simplification and is to be regarded as a convenience of presentation.

First, obstruction to the air passages. This may occur anywhere from nose or lips to the alveolar-capillary membrane. It may simply be due to blocking of the pharyngeal lumen by the tongue, in an unconscious patient. Foreign bodies, solid or liquid, vomitus or blood, cerebro-spinal fluid or secretions may have entered the lower air passages owing to failure of

188

the protective function of the glottis. There may be a neoplasm of the pharynx or parapharynx, of the larynx, the air passages, the thyroid, or of some intrathoracic tissue, which by pressure narrows or occludes the air channel. Inflammation of the pharynx, especially of the floor of the mouth and of the glottis (the Ludwig's angina type of condition) are associated sometimes with grave respiratory embarrassment; and mediastinitis or pleural effusions may by pressure interfere with free air movement. Narrowing of the lumen of the air passages, as in severe asthma, or paralysis of one or both vocal cords, are other causes of respiratory obstruction. You will be able to think of other conditions which can be added under this heading. Next, let us consider briefly conditions of the lungs themselves which may lead to respiratory inadequacy. Acute pulmonary infections lead often to respiratory distress, though with modern antibiotic therapy this period can usually be reduced to a brief interlude. However, in the recent influenza epidemic not a few patients, often young adults, were admitted to hospital in a state of dyspnoea which often proceeded to unconsciousness and death despite every effort to cope with the infection. Severe bronchopneumonia (often due to a staphylococcus) was found at autopsy. The condition was clearly a failure of diffusion of oxygen aggravated by a failure of circulatory perfusion of large parts of the lung fields. Added to this was an intense toxaemia. Artificial ventilation was of little help and tracheotomy seemed to offer the best chance, presumably by reducing the deadspace and allowing easier clearance of secretion by suction through the tracheostome. If the organism was sensitive to antibiotic influence the patient sometimes survived.

A patient with normal lungs who acquires an acute infection which produces pneumonia may, by increasing his ventilation to its maximum, keep carbon dioxide from building up to any lethal extent. When lung has consolidated, the venous blood from the pulmonary artery perfuses through unaerated lung and returns to the heart still as venous blood. This is the picture of a patient with pneumonia who is cyanosed, has tachypnoea, and a normal or near normal pCO_2. But when an acute infection strikes someone whose breathing mechanism is already altered by emphysema, maximum breathing capacity is already so limited that no increase of ventilation that the patient can produce is adequate to eliminate carbon dioxide. Added, therefore, to the picture just painted is a rising arterial CO_2 tension. This soon reaches toxic level and ventilation, such as it is, is driven mainly by the anoxic stimulus. At this point the unwary may treat the patient to oxygen therapy, increasing the pO_2 and so removing the ventilatory drive and reducing the ventilation to the point of failure. Accurate diagnosis at this stage is vital but not always easy. Unconsciousness may be produced by various catastrophes and it may not be easy to assess the cause of coma in a patient admitted to hospital with an equivocal history. He may have suffered some central vascular

stroke, or be the victim of a metabolic disorder which has got out of control ; he may be the accidental or deliberate victim of drug overdosage, or be suffering from some neurological disease. If the unconsciousness is accompanied by respiratory insufficiency or failure, this must be treated on general principles and clinical assessment without waiting for confirmation of the diagnosis by ancillary aids.

The third division in our classification of respiratory insufficiency includes those causes which are central in origin, affecting directly the areas of respiratory control in the pons and medulla. Depression, by drugs of the hypnotic and sedative class, whether prescribed unwisely or taken accidentally or deliberately in too large an amount, accounts for a number of patients admitted as respiratory emergency problems to hospital.

The function of the respiratory control areas may be affected by trauma. As a result of head injury actual destruction of brain tissue may occur, or haemorrhage or raised intracranial pressure may embarrass the centre. Vascular catastrophes, haemorrhagic, thrombotic, or embolic, may for a time affect respiration as may the presence of an intracranial tumour. After severe neurosurgical operations sudden respiratory failure is not unknown and must be treated promptly and energetically.

Certain metabolic disorders when uncontrolled may produce coma and adversely affect respiration. Renal insufficiency, diabetes mellitis, and eclampsia are three such diseases where it may fall to the lot of the anaesthetist to treat such respiratory failure whilst the physician bring the disease under control.

Carbon dioxide intoxication is of course the central cause of respiratory failure following upon any condition which reduces ventilation below a point when carbon dioxide elimination is adequate.

The fourth cause of respiratory insufficiency is interruption of transmission of nerve impulses between the brain and the muscles. The classic example of this is of course in anterior poliomyelitis affecting the cervical cord and that aspect of the disease which attacks the brain stem as well and is known as spino-bulbar poliomyelitis. It is in this field that the anaesthetist really first came into the clinical team, in the Copenhagen epidemic of 1953, and where perhaps the most spectacular results have been achieved. Lassen and Ibsen managed to reduce the mortality of spino-bulbar poliomyelitis in their great outbreak from 80 per cent. to about 30 per cent. by the application of principles of treatment which we shall consider in a minute. Other conditions included in this section are polyneuritis, myasthenia gravis, and high cord injuries ; and, of course, tetanus, the toxin of which attacks at the same places as the polio virus, i.e., the anterior horn cells of the cord where it abolishes synaptic inhibition, producing disorder of tone or spasms of opposing muscle groups ; and sometimes the brain stem.

190

Lastly, we must bear in mind conditions affecting the muscles of respiration themselves. Various myopathies occur and may produce respiratory insufficiency of gradual and insidious onset. More often a patient who manages a sedentary life just short of trouble is precipitated into failure by an acute infection which produces demands upon respiratory activity which he is unable to meet ; much as the emphysematous patient, about whom we have been talking, is precipitated into coma and respiratory failure by the acute upper respiratory infection. Injuries to the thoracic cage in the form of fractured ribs, or disruption of the whole function of the cage as occurs in " flail chest " can profoundly reduce respiratory efficiency. Acute pain, such as is experienced in pleurisy, or as a result of upper abdominal or thoracic surgery, may reduce muscle activity to a point where ventilation becomes dangerously inadequate.

TREATMENT

The anaesthetist's role

Whatever the cause of respiratory insufficiency the initial treatment must be based on two principles : (1) to establish and keep a clear airway, and (2) to maintain adequate oxygenation and ventilation. Until these two essential conditions have been fulfilled the patient's life is in jeopardy and not until they have been safely achieved can the cause of the condition be treated with any hope of success. Respiratory insufficiency must be appreciated and treated much sooner than it usually is. The place for the application of basic principles of treatment of cyanosis, dyspnoea, or of course apnoea, is in the home, during transport, or in the casualty department (or wherever first seen), and not an hour or more later in the ward. Whatever the cause of the respiratory inadequacy it will be made worse and possibly rendered irreversible by hypoxia.

If obstruction is present and is of recent origin and there is no central effect of carbon dioxide retention, removal of the obstruction or by-passing of the block is the initial measure required. Endoscopy, suction, aspiration and positioning may effect clearance of the air passages. If the obstruction persists or is likely to recur, intubation will be necessary and may have to be succeeded by tracheotomy. All this is self-evident and your training as an endoscopist ensures you a place in the therapeutic team.

Whether respiratory failure is due to disease of the lungs and secondary carbon dioxide intoxication, or whether it is due to retained metabolites, or to central vascular causes or central drug depression, or is due to neuromuscular conditions, the anaesthetist's role in the technical application of aided respiration is the same. The first measure is airway clearance. Preliminary observation by direct laryngoscopy, followed, if necessary, by bronchoscopy and aspiration of secretions or aspirated material from the trachea and bronchi, must be undertaken thoroughly.

Bronchoscopy will usually be succeeded by intubation and the establishment of adequate ventilation and oxygenation by hand bag squeezing. Sometimes treatment along these lines may be all that is required. Ventilation for half an hour with a high minute volume will wash out the retained carbon dioxide, and the restoration of the patient's consciousness and voluntary control of respiration may allow medical treatment to take over. This will consist of an antibiotic attack if infection has precipitated the crisis, broncho-dilators, aerosols, drug antagonists, and so on. The single episode of airway clearance and ventilation may suffice.

More often the decision will be made after airway clearance to ensure integrity of the air flow for a prolonged period. The endotracheal tube may remain in place for a limited time only, out of respect for the glottis and because its presence causes its own disruption of comfortable and quiet respiration, whether voluntary or assisted. The question of tracheotomy must now be faced.

Tracheotomy

I think that a tracheotomy done in time is probably the most important single therapeutic measure that we can undertake in helping these often difficult cases. What are the indications for tracheotomy ? First, is glottic control still adequate for the defence of the lungs ? Clinically is there dysphagia or coughing on attempting to swallow ? Physiologically is the reflex from receptors through central nuclei to effector activity working properly ? Secondly, does accumulation of secretions necessitate repeated aspiration in the absence of the patient's ability to clear his air passages by coughing ? Thirdly, will a reduction of deadspace be of assistance in re-establishing respiratory sufficiency ? Fourthly, must respiration be artificially assisted ? Lastly, for how long is all this going on ? On the answers to these questions depends the need for tracheotomy. Failure of glottic integrity demands immediate protection for the lungs from aspiration of pharyngeal secretions, fluids, vomitus, blood or cerebrospinal fluid. Repeated bronchoscopic aspirations are disturbing and unpleasant for the patient, possibly traumatic and altogether unpractical. Tracheotomy, by reducing the deadspace in those cases where tidal volume has fallen below adequacy, may *per se* restore a minimum of respiratory sufficiency. If the patient must be ventilated artificially with some sort of pump a sealed tracheotomy is essential. If the need for intubation is likely to be longer than a few hours, or a day or two at most, then a tracheotomy is preferable to a per glottic endotracheal intubation.

A word or two about the technique of tracheotomy in these cases. The operation is best done under a general anaesthetic, and done if possible deliberately and in time and not as an emergency. Anaesthesia may be induced and maintained with cyclopropane, nitrous oxide-oxygen, and halothane, or other inhalation techniques administered via an endo-

192

trach al tube. The tracheostome should be as high as possible and the open ng in the trachea square or diamond shaped. These last two details are o course to ensure a firm tube fixing, and to allow room for the tube in the trachea above the carina. The tube itself should be of rubber or plastic, short bevelled and with a short inflatable cuff. There are several very efficient tubes available on the market at this time.

Artificial ventilation

Now let us consider briefly a few details of assisted or artificial ventilation. This may be carried out in a number of ways. Hand bag squeezing is the simplest method, and one which will probably be employed initially in many cases. For any length of time it is tiring and disrupting to hospital routine in that it demands the organization of the staff on shift work ; it has, however, been carried on for days and was the main source of respiratory power in the great Copenhagen epidemic (medical students were mostly employed). A tank or cabinet respirator may be used but has many drawbacks, particularly in those cases where secretions are troublesome and where a tracheotomy has been performed. A Cuirass respirator is unsatisfactory save in special cases during recovery from more profound respiratory paralysis. Phrenic nerve stimulation is theoretically possible but impracticable for prolonged use. Finally there are a number of respiratory pumps, pulmoflators, etc., on the market, and it is one of these which is usually used in these days to assist, or control artificially, respiration which is inadequate or absent. Intermittent positive pressure respiration (I.P.P.R.) may have to be carried on for days, weeks, or even for months. I am not going to discuss the merits and drawbacks of the several available machines—you have had a chance of seeing many of them for yourselves ; but a few remarks on the use of, and requirements we demand of, a machine of this type may be helpful. Remember that when we resort to I.P.P.R. we are going to upset the dynamics of the normal respiratory pattern, especially of inspiration. The normal intra-pleural negative pressure which by increase of the volume of the thoracic cage in voluntary inspiration draws air into the lungs as they expand to fill the vacuum, is replaced in I.P.P.R. by a positive pressure inflation of the lungs and forced enlargement of the thoracic cage from within. The effect of the " thoracic pump " in assisting blood-flow in the great veins towards the heart is lost and an adverse effect may be produced upon the circulation. This may be serious in a patient suffering from circulatory failure resulting, perhaps, from the respiratory crisis for which treatment is being applied. Again thoracic compliance (as it is now called) varies greatly from patient to patient, and in the same patient from time to time depending on his state of consciousness, the flaccidity of his muscles of respiration, his own voluntary respiratory efforts, the presence of atelectasis or lung consolidation, and so on. We must look for certain requirements, then, in a pump which will minimise dangers resulting from such conditions as I have mentioned. We shall look for flexibility in the

pattern of the imposed artificial respiration. The machine should be capable of varied speed, stroke volume and pressure of inflation. It should provide an absence of resistance to expiration, allowing an unimpeded fall to atmospheric pressure. The question of providing a " negative phase " at the end of expiration must be considered. In theory it is obviously a good thing, minimizing the adverse effect on venous return to the heart and ensuring emptying of the lungs to a normal extent, an important point in the emphysematous patient whose elastic recoil in expiration is defective. In addition a machine may be " patient triggered "; that is, that it will respond to a patient's own respiratory effort and will carry an inadequate inspiration to fulfillment of adequacy. This again in theory may be an asset and occasionally in practice is so. But often the patient with ineffective voluntary efforts at inspiration has such a degree of tachypnoea that there is no advantage to be gained in trying to follow the patient's respiratory pattern. It is often better in such cases to override the ineffective respiratory attempts, or in some cases to abolish such attempts by curarisation. This course may be applied most urgently in the treatment of severe tetanus, about which I want to say a word or two later when we consider some problems of particular diseases and conditions.

It is necessary, when applying artificial respiration for any length of time by whatever means, to have some idea of whether what we are producing is adequate or not ; or indeed is over adequate. The measurement of the minute volume of our ventilation will guide us here and some form of gas meter or volumeter should be incorporated in the respiratory circuit, preferably on the patient's expiration side on the principles that what comes out must have gone in ! In actual fact, hyperventilation is more probable than underventilation provided the air passages are clear and there is no pulmonary collapse or other condition present limiting pulmonary diffusion or thoracic compliance. In practice this overventilation does not seem to matter, though theoretically it might produce the less desirable consequences of alkalosis, such as upset in the dissociation curve of haemoglobin, and so limit tissue oxygen uptake, or produce tetany or renal calculi.

Whilst we are considering the technical problems of ventilation I must emphasize the dangers of complacency. Ventilation which appears adequate and smoothe may, an hour later, be quite inadequate and the patient's general condition may have changed remarkably for the worse. The cause of such a change may be one of several. Underventilation may cause a severe respiratory acidosis, and a rising pCO_2 and falling blood pH are signs of approaching medullary poisoning. The patient may be " fighting " the pump by his own increasing efforts to establish voluntary respiration. Obstruction may have developed, mechanically or by collection of secretions in the air passages, or by atelectasis. Inadequate diffusion may have developed due to the effect of hypoxia on alveolar

epithelium or from pulmonary oedema ; perhaps circulatory failure peripherally or of the pulmonary circulation may have developed.

You see, these patients need very careful supervision and their general management is not easy. The most important single item in their treatment is good nursing by nurses specially trained to look after such cases. They must be " specialled " all the time and never allowed to be under intermittent nursing care, and although their general management becomes largely a nursing problem, they need pretty constant medical supervision as well. Case recording plays a most important part in successful management, and an " on paper " picture of the patient's state makes the detection of deviation from a very narrow path more likely. Besides the frequent recording of temperature, pulse and blood pressure, the minute volume of respiration and a fluid intake-output chart are a *sine qua non* of observation. It is a good practice twice daily to estimate blood and urine pH, total and combined CO_2 in blood, electrolytes, and urine concentration. If all this is kept graphically charted a clear picture of progress is instantly presented.

Nutrition needs careful supervision and a large bore stomach tube for feeding is essential. Gastrostomy has been advocated and I have been concerned with the management of a child with severe tetanus in which a gastrostomy served admirably. If nutrition, water intake, and electrolyte balance can be maintained by gastric feeding so much the better. Intravenous infusion day after day and possibly week after week, can become a nightmare. If it is necessary a polythene catheter well into the vena cava will confer some degree of mental tranquility upon medical and nursing attendants. Aspiration of secretions through the tracheostome will be necessary—sometimes half-hourly, more fortunately, every two to four hours. A humidifier is a necessary part of the respiratory equipment, as the normal air-moistening function of the naso-pharynx is by-passed. The use of aerosols helps to keep secretions liquid and more easily aspirated.

Physiotherapy plays a most important part in treatment and constant change of position from side to side and alteration of the tilt of the bed may prevent pulmonary atelectasis. When this occurs, as it will with greater or less frequency, vigorous postural drainage with percussion over the affected pulmonary segments will often clear the air passage and allow the portion of lung to re-expand. Failing this, bronchoscopy through the tracheostome must be employed.

Very briefly, there is an outline of the approach to these cases of respiratory insufficiency. The respiratory team will consist of a physician (in charge), an anaesthetist, a surgeon to perform the tracheotomy, a biochemist, a physiotherapist, and (above all) a supply of trained senior nurses. There is, of course, a very strong argument in favour of establishing special units in large centres of population to which cases of respiratory disease, who may need such skilled care as I have described, can be sent.

195

15

Whatever the pros and cons of special units for this or that disea e or condition, it is the training of personnel in difficult techniques and the employment of special equipment and laboratory facilities which may make the difference to the successful outcome of the management of a patient with respiratory insufficiency or apnoea.

Some special problems

Although the anaesthetist's part in the management of patients with respiratory insufficiency is essentially the same whatever the cause, there are a few problems or matters of interest which are peculiar to certain conditions or diseases. Whereas in " polio " the paralysis which affects the respiratory muscles is a flaccid one, and I.P.P.R. is, in theory, easy to apply and control inasmuch as pump activity is unopposed, in tetanus respiratory insufficiency is spasmodic and varies from occasional periods of dyspnoea with or without cyanosis in the less severe cases, to violent locking in spasm of all the respiratory muscles leading to a state of acute asphyxia.

There is much argument and debate as to what is the best pattern of management of tetanus. There are those who claim that treatment, apart from sedation, has really not improved the outlook for sufferers from the disease. The most extensive review so far published from New Orleans, of over five hundred cases, supports the view that the modern techniques of treatment have not affected the mortality of the disease, which is anyway declining naturally, even in areas where immunisation is not commonly practised. But so often claims are made for a new treatment, or appeals made for the retention of older and more conservative methods, and the new techniques derided, without first examining the prognostic criteria of each individual case. In tetanus we have two indications of the likely severity of the disease ; the incubation period, i.e., that time lag between injury and the onset of the first symptoms, usually muscle stiffness, and the period of onset (as it is called), which is the interval between the appearance of the first symptoms and the first generalised spasm. Of these, the period of onset is usually regarded as the more significant, and if amounting to less than forty-eight hours is of grave prognostic importance. Obviously the milder cases with little or no spasm, and probably little or no respiratory insufficiency, can be successfully managed with sedation and drugs, such as mephenesin or some of the phenothiasine family, especially chlorpromazine, which inhibit muscle spasm or increased tone. However, when the prognostic criteria suggest a severe attack or when the disease is of the fulminating type, it seems to me probably better to anticipate trouble than to find oneself battling with established crisis. It is my opinion that as soon as it becomes evident that acute spasms are not controlled by sedation and chlorpromazine, and especially if the vagal control of the glottis is threatened, as shown by dysphagia, tracheotomy should be performed and maintained, of course, with a cuffed tube. Thereafter, if respiration is disorganized by a failure

196

to control spasms, the patient can be given a muscle relaxant and I.P.P.R. carried on as already described. This full régime, which makes very heavy demands upon nursing and medical staff, and which may be impossible to apply in many parts of the world where tetanus is rife, will undoubtedly save lives which heretofore would have been lost. But it must be applied ruthlessly and thoroughly and complete muscle relaxation maintained for as long as the acute spasmodic phase of the disease lasts. What muscle relaxant is the best I do not know ! But here is one pointer. Succinylcholine given as an intravenous drip would appear of advantage in that its effect can be rapidly increased or diminished to follow the fluctuating needs of relaxation. But the need of maintaining an intravenous drip of one hundred per cent. efficiency day after day and night after night, and relating the dosage of the drug to fluid intake or load on the circulation, adds a technical complication to the case management which will be avoided by the use of a longer acting relaxant such as tubocurarine chloride given intermittently through an indwelling needle such as a Gordh. Central sedation, and probably the use of chlorpromazine also, for its effect in co-ordinating the activity in the reticular systems of the midbrain, should be combined with relaxation and I.P.P.R. The effect of the toxin on the brain stem may be suggested by hyperpyrexia which is regarded as a grave event and often pressages a fatal outcome. But I think it probable that if this hyperpyrexia can be controlled by artificial cooling there is no reason why central cells in the brain should not recover just as completely from the effect of the toxin as those of the anterior horn cells of the spinal cord.

A patient suffering from myasthenia gravis may pass into a state of respiratory crisis and present a pharmacological problem. As the maintenance dose of neostigmine is increased to meet the rising demand, its input may rapidly overtake its elimination and a cumulative effect be produced. Neostigmine in high concentration may act as a neuromuscular blocker in its own right and may quickly produce respiratory failure from muscle paralysis. Controlled I.P.P.R. must be continued for some days whilst the drug is eliminated and gradual weaning practised. Sometimes thymectomy will be performed during this phase and respiratory assistance should be continued for some days post-operatively. Small test doses of edrophonium (tensilon) will provide a sensitive indicator of the stages of resolution.

In the management of drug intoxications involving respiratory depression, mechanical assistance will of course be accompanied by exhibition of the appropriate antagonist, of which nalorphine, amiphenazole, or levallorphan are three which are effective in opium poisoning or that due to pethidine. Bemigride used effectively in cases of barbiturate poisoning, still is not certain of its place among the specific antagonists. It will often relieve respiratory depression but seems to have little effect in shortening the period or depth of unconsciousness of the patient.

197

Asphyxia neonatorum is another condition of respiratory crisis which the anaesthetist may find himself called upon to succour. The possible causes of a baby not breathing are the same as those I have mentioned earlier, plus two extra conditions ; prematurity and congenital abnormality. The controversial points in the management of this condition are, when to interfere beyond the ordinary routine measures of resuscitation ; and the merits of intragastric and endotracheal oxygen. As good a guide as any that time is running out is the rate of the baby's heart beat. Bradycardia, increasing over a minute in an apnoeic baby, calls for a greater measure of active resuscitation than sucking, slapping, or rocking. I know of no evidence that intragastric oxygen will initiate respiration. It does allow of some diffusion of oxygen through the gastric mucosa, provided that there is a circulation. Endotracheal oxygen insufflation achieves the same but in addition can, by very carefully controlled intermittent positive pressure, be made to affect the stretch receptors in the lungs and initiate the Herring-Brewer reflex and so provide a physiological stimulus to respiration. As long as it is clear that the object is not to inflate the infant's lungs, but to raise intermittently the intra-tracheal and bronchial pressure, and of course as long as there is somebody present who can intubate a neonate atraumatically, it seems to me that intra-tracheal oxygen wins hands down over intragastric oxygen.

SUMMARY

The management of cases of respiratory insufficiency is often an exacting and disappointing business. In severe cases the chances of death from pulmonary infection or from technical mishap are never far away. Many cases are hopeless from the start and this is especially so where the lungs themselves are affected by chronic disease. In head injuries and in cerebral vascular catastrophes the damage to the brain cells is probably rendered irreversible by early and avoidable periods of anoxia. But where initial lung function is normal and where recovery from the acute disease is predictable after a given period of time, patients in danger of death from respiratory insufficiency can, I suggest, be saved by treatment along some such lines as I have indicated.

APPOINTMENT OF FELLOWS AND MEMBERS
TO CONSULTANT POSTS

D. A. MACFARLANE, B.SC., M.CH., F.R.C.S. Consultant Surgeon to St. Helier Hospital Group.

A. G. QUINLAN, M.B., B.S., F.R.C.S. Consultant Orthopaedic Surgeon to Scarborough Group of Hospitals and to Adela Shaw Orthopaedic Hospital, Yorks.

R. H. SHEPHARD, F.R.C.S. Consultant Neuro-surgeon to Derby Group of Hospitals.

The Editor is always glad to receive details of new appointments obtained by Fellows and Members, either through the Hospital Boards or direct.

ADMISSIONS TO THE HONORARY FELLOWSHIP

AT THE QUARTERLY Meeting of the Council on 10th July, Dr. Warren H. Cole of Chicago and Dr. Charles William Mayo of Rochester, Minnesota, were admitted as Honorary Fellows.

Presenting Dr. Cole, Professor Ian Aird addressed the President and Council as follows :

Warren Henry Cole has long been a friend of England and a personal friend of the members of this College. There are few of us here who have not experienced the warm hospitality of Dr. Cole add his charming lady in their delightful lakeside home in Chicago. Yet it is not on grounds of gratitude primarily that I present Dr. Cole to you now. He himself would, I think, like to be regarded in the first place as a research worker. In the case of some research workers it takes lengthy descriptions to describe their productions and sometimes the value of a piece of research is in inverse proportion to the space which must be devoted to describing it. Dr. Cole has made my task easy, for he has been responsible for important discoveries which can be described in a word.

All of us in some measure hanker after immortality. Dr. Cole achieved that happy state thirty-four years ago when he was a young resident of twenty-five years of age. With Dr. Evarts Graham he discovered cholecystography and thereby armed us all with one of the most important diagnostic weapons of modern times, and he opened a field which made possible the precise estimation of liver efficiency, which before him had not been possible. I find it a matter of regret that much of the colourful romance of his discovery has been destroyed subsequently by the chemists, and the rich purple liquid which we used to pour

Professor Warren Cole receiving the Honorary Fellowship from the President, with Sir Russell Brock and Sir Archibald McIndoe (Vice-Presidents) watching.

at dead of night into the veins of patients has been replaced now by a couple of tablets.

In the later twenties and the thirties Dr. Cole made other discoveries, important in surgery and pathology, which any of us would have been proud to make and which were secondary in importance only to his first achievement. In that time also he established himself, as not all surgical research workers do, as an operating surgeon of the first brilliance. For his operative field he chose the tiger country of the hilum of the liver and his cautious, but single-minded and courageous advance in the vascular jungle towards the stump of a common duct stamps him as a surgeon not only of wisdom and carefulness but of courageous tenacity. In many other fields, and notably in respect of cancer of the thyroid gland Dr. Cole made valuable contributions to surgical science in the years between the wars.

It is fortunate that he got his surgical chair early, for he has built in the University of Illinois a teaching school and a research department second to none in the world. This has come to fruition in the post-war years and in his later researches, Dr. Cole has guided a brilliant young team straight to the heart of the cancer problem. Under his guidance a sure method has been elaborated of detecting malignant cells in the venous blood leaving a tumour at operation and in the peripheral circulating blood, and he has inspired an all-American attempt to reduce by chemotherapy at and after operation the distant metastases which so often circumvent the cancer surgeon's work.

These were arguments enough for bringing Dr. Cole before you to-day but we should remember too that he has been a President of our sister College across the water and has for years now been a Regent, and by all acknowledgement a most responsible Regent, of his own national College.

I have the honour, Mr. President, to present to you Warren Henry Cole to receive at your hands the Honorary Fellowship of the College.

The citation in honour of Dr. Mayo was delivered by Sir Archibald McIndoe, Vice-President, in the following terms :

An Honorary Fellowship in the Royal College of Surgeons has never before been independently conferred upon a father and a son. It probably never will be again. This occasion is, therefore, unique.

The older Members of Council, who remember William and Charles Mayo, will take great pleasure in it ; the younger will admire the achievement of Charles William. To them, as to every surgeon in the United States of America, he will be more familiarly known as Chuck Mayo. He is the only surviving son of Charles Horace Mayo, who received the Honorary Fellowship of this College in 1921 at the hands of Sir Anthony Bowlby. His uncle, William James, received his Fellowship from Sir Rickman Godlee in 1913.

There can be no question that the Mayo brothers were the greatest surgeons America ever produced and it is no less certain that their influence on American and international medicine was almost incalculable. No account of surgery is complete without their romantic and incredible story. Suffice it to say that as a result of their work there are scattered over forty-two countries of the world some four thousand Fellows of the Mayo Clinic. The beneficial influence of this alone, apart from the purely scientific contribution of the Clinic, is formidable.

The Mayo brothers died in 1939 within three months of each other. Charles William Mayo succeeded them. A lesser man would have crumpled beneath the burden of his frightening inheritance. It might also have been expected that all would have been made easy for him, that his path would be smoothed and his advance assured. Neither of these things happened. In 1929 he was to have become Chief Assistant to his father and the father had looked forward

200

immensely to training the son. On the very day that this was to come about Dr. Charlie suffered the first of a series of strokes which were eventually to carry him off. Charles William never assisted his father. It was a tremendous disappointment to both but it did not deter the young surgeon. His training was then undertaken by the incomparable William Starr Judd, whom Moynihan regarded as the finest technical surgeon he had ever seen. It was completed by Verne Hunt and Donald Balfour—the latter also an Honorary Fellow of this College.

Charles William worked incessantly and trained himself in surgery with that intensity seen nowhere else but at the Mayo Clinic. His interests, like his father's, were principally abdominal and his contributions to colonic surgery have been notable. Recognition of his considerable position in surgery came slowly, for few people would willingly believe that the son could approach the stature of the father. To-day, however, his position within the Clinic is such that he is regarded as the leader of that great organisation. Outside it he is nationally recognised as one of the outstanding surgeons of the United States and he has been acclaimed for his work in the international field on behalf of the United Nations. Just a few months ago the Journal of Postgraduate Medicine, of which he is Editor-in-Chief, was declared the finest medical publication in the United States. Much of this is due to him.

He is known to all who visit the Mayo Clinic for his competent straight-forward surgery so characteristic of that great organisation, for his quiet, dry humour, so reminiscent of his father, and for the generous hospitality which he and Mrs. Mayo dispense at Mayowood to hundreds of visiting surgeons. As a surgeon who was once a part of the Mayo Clinic I would say that it is exceedingly fortunate that the spirit of the father lives on in the son.

I, therefore, have much pleasure, Mr. President, in presenting to you Charles William Mayo to receive at your hands the Honorary Fellowship of this College.

The President welcoming Dr. Charles Mayo to the Honorary Fellowship, with Sir Archibald McIndoe and Sir Russell Brock (Vice-Presidents) in the background.

201

THE HUNTERIAN MUSEUM

A GUIDE TO the Hunterian Museum (Physiological Series) has now been published. It has been compiled by the Curator, Miss Jessie Dobson, B.A., M.Sc., at the request of the Trustees of the Museum and the Council of the Royal College of Surgeons, where this famous museum is situated.

" The guide has been prepared in order to give those making their first visit to the Museum a brief account of the particular features of the Hunterian Collection."

" The original collection of John Hunter (1728-1793) illustrated the anatomy and physiology of the animal kingdom in comparison with specimens from the human body ; a part was also devoted to comparative pathology." The Physiological Series comprises that part of the museum demonstrating the relationship of the normal structure and functions of living animals.

" The original Hunterian specimens may be recognised by their black numbers and the presence of a red mark at the top of the jar. Preparations added after Hunter's time but before 1941 bear red numbers ; and those prepared after 1946, when the reconstitution of the Museum began, are numbered in blue."

John Hunter, having been advised in 1760 to go abroad on account of his health, was appointed a staff surgeon in the Army and in 1761 went to Belleisle and in the next year to Portugal. He commenced to build up his museum on his return to London in 1763 using the two hundred specimens which he brought back with him as the nucleus ; when he died in 1793 the collection consisted of approximately 13,500 specimens. His museum was not merely a mausoleum containing a series of exhibits, for it illustrated his theories of the constant adaptation of structure to function in living things.

It could broadly be divided into two aspects of life ; first, to illustrate the preservation of the normal and, secondly, the propagation of the species for the continuity of the race. His wish was that after his death the collection should not be disposed of piecemeal but as a single entity. This precious collection on which Hunter had spent so much time, thought and money (£70,000) during his life was, after his death, stored in the premises in Leicester Square, guarded by William Clift, his last pupil and assistant, a boy of eighteen, as custodian on a wage of seven shillings a week and a small allowance for the purchase of spirit with which to replenish the specimen jars. When Hunter died in 1793 Clift had only known him for twenty months but in that short time his teacher's influence was such that he cheerfully lived in penury for seven years to show his loyalty and devotion. In 1799, Parliament voted £15,000 for the Government to purchase the collection and in order that it should be properly maintained it was offered for safe keeping to the Royal College of Physicians which refused it, as did also the British Museum ; finally, the Corporation of Surgeons by a unanimous

202

vote taken on 23rd December 1799 agreed to receive it on the conditions laid down. In July, 1800, the Council formed a Board of Curators and appointed Clift as the first conservator at a salary of £80 per annum later increased to £100. Trustees for the museum were appointed with the duty " to keep the collection in as perfect a state as possible." They have done this ever since in co-operation with the Council of the College ; two of the Trustees are co-opted as members of the Museum and Research Committee to act as a liaison between the two bodies.

The collection was left in the premises at Leicester Square, but in 1806 the lease came to an end so it was removed to a house, 42, Lincoln's Inn Fields, which had been purchased by the Council of the Royal College of Surgeons in 1803 ; the Corporation of Surgeons had been re-established in 1800 by George III, by Royal Charter, as the Royal College of Surgeons in London. More space was needed to exhibit the collection adequately, so the Council commissioned George Dance (the younger) to prepare plans for " a large and impressive building." George Dance, R.A., had succeeded his father in 1768 as the City Surveyor and Architect of London, he was a founder member of the Royal Academy. An approach was made to Parliament, who voted sums totalling £27,000 towards the expense, and this, with £21,000 provided by the College, enabled the work to be commenced in 1806 ; the new building was officially opened for visitors on 18th May 1813. The Collection had been viewed by a few visitors ever since 1801, but after the Prince Regent had visited the new premises on 28th July 1813 many people of all nations came to view the Museum and, in consequence, it became and has since remained truly international.

There were many museums in this country and elsewhere before John Hunter commenced his collection, the earliest of which there is record is that which Ptolemy Soter erected in Alexandria (298 B.C.). This with the library expanded into what we would regard as a university, but after its final destruction (A.D. 390) the term " museum " fell into disuse until the seventeenth century. The development of medical education caused a need for museums owing to the difficulty of obtaining and preserving material for anatomical dissection and teaching. The use of alcohol for preservation of specimens was probably introduced by Robert Boyle (1627-1691) ; in spite of the opinions to the contrary it is doubtful if the whole bodies of dead Crusaders were sent home in a preservative. Having no preservatives available other methods for forming museums were used such as wax models, dried specimens and those made by " corrosive " and injection methods. The art of illustration, while delaying the development of museums, did supply a long felt want, and still does if used to supplement the actual specimens. The great improvement today in medical illustration does tend to lead to a neglect of the use of museums by the student. However great may be the development and improvement of medical illustration it can never really replace the educative value to a student of seeing and handling the actual specimen, even dissecting it

203

and subjecting it to further microscopical investigation. From the time of obtaining the Charter in 1617 the Society of Apothecaries encouraged the study of botany and the collection of plants and herbs during pre-arranged outdoor excursions. These were regarded as so important that after 1633 fines were imposed on those apprentices who failed to attend. The importance of physic gardens in the study of Materia Medica is well known. The idea behind the formation of museums, such as that of the Royal Society (1681-1781), the Ashmolean at Oxford (1683), at the Royal College of Surgeons of Edinburgh (1694) and of Dublin (1785), was to create a collection which would mainly illustrate departures from the normal, but that of John Hunter was in a different category. A museum is like a living organism, it requires continual care, it must grow or it will perish. The new acquisitions which have been made to John Hunter's museum have been carefully selected, placed in their proper sections and not acquired just to fill up the shelves.

The Royal College of Surgeons has always been fortunate in the various conservators, curators and technical assistants who have worked in the museum with such devotion during the last hundred and fifty years and not least in having Miss Jessie Dobson as the present curator. She accompanied the late Professor Frederick Wood-Jones from the University of Manchester, where she was his personal assistant in the department of Anatomy, when he accepted the invitation of the Trustees and Council in 1945 to become the Conservator. She was appointed Recorder in the department of Anatomy at the College, then Recorder in the Museum and, in 1954 when Professor Gilbert Causey was appointed the Sir William Collins Professor of Human and Comparative Anatomy and Conservator of the Anatomical Museum, she became Curator of the Museum. For the last three years she has given an annual Arnott demonstration. These demonstrations are on advanced surgical pathology illustrated by speci-mens from the museum ; they were endowed by Mr. James Moncrieff Arnott, F.R.S., who was President of the College in 1850 and 1859. She does no teaching officially in the basic surgical science courses, but is always so courteously and willingly available for answering enquiries made by those studying in the museum. She has a vast knowledge of everything appertaining to the work of William and John Hunter and other famous British surgeons since the beginning of the eighteenth century. Those surgeons who have to prepare and give any of the statutory lectures or orations at the College will find that she has an abundance of valuable information which she is always ready to place at their disposal. She is the author of many papers, which have appeared in the Annals, and addresses given to learned societies dealing with the history of the College and the specimens in the museum. She is the author of " Anatomical Eponyms " (1946 published by Messrs. Ballière, Tindall & Cox), " William Clift " (1954 published by Messrs. Heinemann Medical Books Ltd.) and " Sir George Buckston Browne " (1957 published by E. and S. Livingstone)

which she wrote in collaboration with Sir Cecil Wakeley, Bt. Sir George Buckston Browne in 1927 provided the British Association with the funds necessary to preserve and turn into a museum the house in which Charles Darwin in 1858 wrote " The Origin of Species " and several of his other books. He lived at Down House, in the village of Downe in Kent from 1842 till his death in 1882. After the death of Mrs. Darwin in 1896 the house became a school for girls and was still used as such in 1927 ; the lease did not expire till 1942. Sir George Buckston Browne provided a sum of £30,000 to purchase the property and lease and to endow it as a museum in memory of Charles Darwin. He obtained most of the original furniture which had been used in the reception rooms and study from various relatives and elsewhere in order to restore it as it had been in Darwin's time. Miss Dobson has recently made a new catalogue of the contents of the ground floor rooms which form the museum.

During the last thirty years of his life many of John Hunter's pupils came from the United States and on their return spread his teaching in that country. Two of the best known museums in America are modelled on the Hunterian Museum, namely the Warren Museum at Harvard founded by John Collins Warren and that at the Wistar Institute of Anatomy and Biology in Philadelphia.

John Hunter and his friend Dr. George Fordyce, realising the educative importance of medical societies, founded, in 1783, the Lyceum Medicum Londinense which met each week in his museum in Leicester Square when he showed and described to the members any new acquisition he had obtained to add to the collection. The late Professor George Grey-Turner considered that " the hey-day of the museum coincides with the regime of that great conservator Sir Arthur Keith, F.R.S., who spent twenty-six years (1908-1934) of his life in nursing the collection."

It contained an approximate total of 65,000 specimens. " Anatomists cherished the marvellous collections in comparative Anatomy and Osteology and the Physiological Series."

For some time before the war the President and Council, fully conscious of possible risks to the collection by enemy action, took steps to place it in as secure a place as possible, which was a series of specially strengthened sub-basement store-rooms and tunnels beneath the College. An overwhelming disaster befell the collection on the night of 10th May 1941 when, during an enemy aerial bombardment, the College received a direct hit by a high explosive bomb. The subsequent conflagration destroyed many thousands of specimens but the loss in the Hunterian Collection, except amongst the Physiological Series, was less than in other portions.

Since 1946 the Presidents and Council have been mainly occupied in the rebuilding of the College and reconstituting this precious and unique collection according to the ideas and ideals of John Hunter, so as to maintain it as a permanent memorial to his thought and work. The Council has had the most generous financial support from well wishers

205

of the College living in all parts of the world. The Trustees in co-operation with the Council are endeavouring to place the collection in a shrine worthy to show homage to the memory of John Hunter and to epitomise the thoughts expressed so vividly in his epitaph, composed by his wife :

> " Here rests
> One whom no common spark of genius fired,
> Whose reach of thought Nature alone could fill,
> Whose deep research, the love of Truth inspired."   E.F.

THE FIRST " GUIDE " to the Hunterian Museum was prepared in 1813, the joint handiwork of Sir Everard Home, then Master of the College, and Sir William Blizard, who succeeded him as Master in the following year and was one of the members of the Board of Curators. This little volume of fourteen pages consisted merely of a numerical plan of the arrangement of the Physiological Series, the order of the preparations being that designed by John Hunter himself for demonstration to his friends and scientific colleagues. A further issue of this synopsis of the contents of the Museum was made in 1818, increased to twenty-four pages to include a record of the considerable additions made in the intervening years.   No mention is made of the pathological collection, nor are individual specimens described.

In 1834 the original building was found to be no longer adequate properly to house and display the greatly augmented collection.   The new museum, completed three years later, consisted of " two apartments, one containing the Physiological, the other the Pathological specimens." At a meeting of the Board of Curators held in July 1844, Richard Owen, then Conservator, pointed out that " the systematic arrangement and location of the different classes and series of specimens being now determined on and approaching completion, the time appears to have arrived when a new Synopsis of the contents of the whole Museum may be prepared with much advantage and convenience to visitors. He would therefore propose that such a Synopsis be drawn up with the view to teach briefly the general scope and objects of the museum, to guide the visitor to the different departments of it and to indicate for the use of the casual and non-professional visitor the nature of the principal objects, especially those which have prominent situations in the Museum. It should contain brief descriptions, with as few technicalities as possible, of the general nature and plan of arrangement of the several series of specimens, with notices of the rarest and most interesting objects in each series ; reference being made to the printed catalogues for the further information of the professional and scientific visitor to the museum for the purposes of study."   The result of this report to the Curators was that Owen was requested to prepare such a synopsis.   This task appears to have taken him seven or eight months for it was not until the 1st of April in the following year that 1,500 copies of this booklet, now extended to eighty-

four pages, were ordered to be printed, the cost being £38 3s. 6d. It contained a brief account of all sections of the collection, including the pictures, with an indication of their location in the different rooms.

Five years later, only about a hundred copies of this issue remained and Owen reported that in any case the synopsis was out of date owing to rearrangement of specimens. Five hundred copies of a revised one were therefore ordered at a cost of £23 10s. 0d.

In 1856, Owen resigned from his post as Conservator and was succeeded by Thomas Henry Quekett who held office for only five years until his death in 1861. On 24th December 1861, William Henry Flower was appointed Conservator and at a meeting of the Board of Curators held in January 1862, he was instructed to prepare a new edition of the Museum Synopsis, this to be ready for the next meeting in February. Presumably Flower managed to achieve this somewhat formidable undertaking, for in March 500 copies were ordered. Further editions of this guide, now containing over a hundred pages, were prepared at intervals during Flower's time and one at least, in 1897, during Professor Stewart's term of office ; but it was not until 1910, soon after Sir Arthur Keith was appointed Conservator, that an entirely new account of the contents of the museum was written. In this, Sir Arthur gave brief descriptions of all sections of the museum, selecting the more interesting preparations for special mention, many of which were illustrated. It was intended to be used by the visitor on his tour of the museum quite literally as a guide to the then very extensive collection.

The Guide to the Physiological Section of the Hunterian Museum recently prepared for the benefit of the visitor is necessarily of a very general nature. Owing to the vicissitudes to which the museum has been and will continue to be subjected for some time no indication can be given of the position of specimens nor even of the number in each section, for the work of replacing losses sustained in 1941 renders this a changing factor. Like Owen's Synopsis of 1845, however, it does " teach briefly the general scope and objects of the museum " and contains " brief descriptions, with as few technicalities as possible, of the general nature and plan of arrangement of the several series of specimens, with notices of the rarest and most interesting objects in each series."   J. D.

DONATIONS

DURING THE LAST month the following generous donations have been received :

Endowment of a Lectureship in Dental History:
  £230   Dr. J. Menzies Campbell.

General Fund:
  £132   Proceeds from sale of gifts from W. R. Gibson.

Chairs for the Great Hall:
      F. W. Allinson. S. W. Allinson.

IMPERIAL CANCER RESEARCH FUND

A DINNER IN HONOUR of Dr. Peyton Rous was given by the Imperial Cancer Research Fund at the Royal College of Surgeons on 22nd July 1958, at which representatives of the Fund and other cancer organizations were present.

In his after-dinner reminiscences, Dr. Rous, who published his first paper on cancer in 1910, spoke of the great debt that all cancer research workers owe to the Fund for the important work which it has done, all along through the years, toward an understanding of the nature of tumours and the solution of the cancer problem. He referred to himself as a child of the Imperial Cancer Research Fund whose influence and aid he had always been proud to acknowledge from his earliest, striving days. In Dr. Rous's view, cancer research today should be done on the broadest front because man still knows but little about the character, treatment and prevention of the disease. Under the new conditions provided by the Fund high achievement seemed to him certain.

Sir Cecil Wakeley, Bt., Dr. Cuthbert Dukes, Dr. Peyton Rous and Professor Sir Roy Cameron having a talk before dinner.

COLLEGE COUNCIL CLUB

THE THREE HUNDRED AND FOURTEENTH meeting of this Club was held at the College of Surgeons on Thursday, 31st July, with Sir Henry Souttar in the Chair. After the secretary, Mr. C. Naunton Morgan, had read the minutes of the last meeting, Sir Gordon Gordon-Taylor proposed the health of the Chairman and in his own inimitable way described the career of Sir Henry from the very early days. Both of them had belonged to one of the surgical travelling clubs and had seen much of each other during visits to clinics overseas. Sir Henry brought a new light to surgery in so much as that he was an experienced physicist and this enabled him to devise many new surgical instruments including one for opening the skull in about three minutes. After all, Sir Henry was the first surgeon to operate on the heart and perform a valvotomy for mitral stenosis.

Sir Henry, in his reply, referred to the many and various episodes which had occurred in his surgical lifetime. Although he was a member of Council from 1933 to 1949 and had enjoyed the meetings of the Council Club ever since, this was only the second occasion on which he had been Chairman. He thanked Sir Gordon Gordon-Taylor most sincerely for proposing his health.

Sir Henry Souttar arriving to take the Chair at the Council Club Dinner.

209

Photograph taken prior to the Council Club Dinner. *Left to right:* Sir Harry Platt, Bt.; Sir Cecil Wakeley, Bt.; Sir Henry Souttar; Sir Hugh Lett, Bt.; and Sir James Paterson Ross, President.

PROCEEDINGS OF THE COUNCIL IN JULY

AT A MEETING of the Council on 31st July, with Professor Sir James Paterson Ross, President, in the Chair, Sir Reginald Watson-Jones, Professor D. M. Douglas and Mr. W. A. Mill were elected members of the Court of Examiners for a period of three years from 31st July.

Lieut.-Colonel R. H. Robinson, R.A.M.C. was awarded the Mitchiner Medal, and Wing Commander W. B. Thorburn was awarded the Lady Cade Medal. The award of the Gilbert Blane medal to Surgeon Commander W. E. Crocker, R.N. was reported.

The Handcock Prize was awarded to Mrs. E. M. Cooke of the Royal Free School of Medicine.

A Diploma of Fellowship was granted to Padmanabhen Narendran, of the University of Madras.

Diplomas of Membership were granted to 125 candidates.

The following diplomas were granted, jointly with the Royal College of Physicians: Laryngology and Otology (22), Anaesthetics (103), Medical Radio-Diagnosis (22), Medical Radiotherapy (9), Industrial Health (9), Psychological Medicine (44), Public Health (16), Pathology (8), Ophthalmology (1), Child Health (2).

Licences in Dental Surgery were granted to three candidates.

The following hospitals were recognised under paragraph 23 of the Fellowship Regulations:

HOSPITALS	POSTS RECOMMENDED		
	General (6 mnths. unless otherwise stated)	Casualty (all 6 mnths.)	Unspecified (all 6 mnths.)
LONDON — Poplar Hospital (Additional)	Senr. Regr. (12 mnths.) Regr. 2 H.S.'s	2 Cas. Offs.	
NORTHAMPTON—Northampton General Hospital (additional)			Regr. (at General Hospital and in Thoracic Surgical Unit, Creaton Hospital)
NORTHAMPTON—Manfield Orthopaedic Hospital (redesignation)			*Redesignation of* Junior Orth. Regr. as S.H.O. (Orth.)
PRESTON—Royal Infirmary (redesignation)			*Redesignation* 2 Orth. Regrs. 2 Urol. Regrs. *instead of* Orth. Regr. Orth. S.H.O. Urol. Regr. Urol. S.H.O. *Under para 23(c)* E.N.T., J.H.M.O. *instead of* E.N.T. Regr.
TYNEMOUTH — Victoria Jubilee Infirmary (additional)	S.H.O.		
AMERSHAM—General Hospital	Extension of period of recognition of post of Surgical Registrar from 6 months to one year		
FIJI—Colonial War Memorial Hospital, Suva	Surgical Officer and Tutor (12 mnths. Gen. Surg. or 6 mnths. Gen. Surg. and 6 mnths. Casualty)		

RESTORATION AND REBUILDING

IT IS NOW eight months since the progress of building Phase IIIa was described in the Annals, and during that time the work has proceeded well.

Partition walls are now complete on every floor and nearly all are plastered also. The floors are screeded at all levels from the top down to second floor, and ready to take their final covering, whether linoleum, terrazzo, granolithic, wood, or tiles. The electrical, hot and cold water services, plumbing, ventilation and lifts are all well advanced. Double windows, to exclude the noise of the street, are being installed on every floor except the fourth, and most of these are in position. Laboratory benches are being fixed in many of the rooms.

Furthest advanced is the fourth floor, part of which will have been made available to the College as a lecture room by the time this article appears in print. This temporary lecture room (eventually to become the dissecting room) replaces the ground floor lecture room (Room 1) which has now reverted to Museum use. The colour scheme of the new fourth floor has

211

16

now become apparent, the tiles on walls and floors being pale grey and the plastered walls being painted to match. The other laboratory floors are being finished in various pastel shades.

Intercommunication with the remainder of the College is afforded on most floors by continuation of the corridors already existing in Phase I. On the ground floor, however, the access is to be more noticeable, and will be by a wide entrance at the back of the Inner Hall into a new rotunda which in turn will lead westwards to the Great Hall and Council Room and eastwards to lecture and committee rooms. This rotunda is now being formed.

The whole Phase is scheduled for completion at the end of March, 1959, but the progress of the work is so good that it is hoped that the date may be appreciably earlier than that.

Meanwhile, the Imperial Cancer Research Fund's builders have taken possession of the houses to the west of the College and have begun the complicated task of strengthening and shoring up the adjoining College wall which must be accomplished before demolition takes place. It is this work which will render the adjacent Room I untenable as a lecture room. Protection and demolition should be finished by about March, 1959, and then the new laboratories of the Imperial Cancer Research Fund will be erected.

DIARY FOR SEPTEMBER

Mon.	15		Basic Medical Sciences Lectures begin.
Wed.	17		D.C.H. Examination begins.
Wed.	24		D.Orth. Examination begins.
Thur.	25		First Membership Examination begins.
Sat.	27		Annual Meeting of Fellows and Members in Cardiff.
Mon.	29		Course in Clinical Surgery and Surgical Lectures and Clinical Conferences begin.
Tues.	30	5.00	PROF. C. J. KAPLAN—Hunterian Lecture—An appraisal of conservative therapy in skeletal tuberculosis*.

DIARY FOR OCTOBER

Wed.	8		Final L.D.S. Examination (Part I) begins.
		7.30	Monthly Dinner.
Thur.	9	2.00	Quarterly Council.
		5.00	PROF. W. E. TUCKER—Hunterian Lecture.
Mon.	13		Anaesthetic Course begins.
Wed.	15		Final L.D.S. Examination (Part II) begins.
		5.00	Board of Faculty of Anaesthetists.
Thur.	16		D.M.R.D. Examination (Part I) begins.
			D.M.R.T. Examination begins.
Fri.	17		Course in Clinical Surgery and Surgical Lectures and Clinical Conferences end.
Thur.	23		D.M.R.D. Examination (Part II) begins.
		5.00	DR. K. M. LAWRENCE—Erasmus Wilson Demonstration.*
Fri.	24		Anaesthetic Course ends.
Mon.	27		Dental Lectures and Clinical Conferences begin.
Tues.	28		Final Fellowship Examination (Ophthalmology and Otolaryngology) begins.
		3.45	DR. A. A. BARTON—Arnott Demonstration.*
Wed.	29		Primary F.R.C.S. Examination begins.
Thur.	30		D.Path. Examination and D.M.R.T. Examination (Part II) begin.
		5.00	SIR JOHN MCNEE—Thomas Vicary Lecture.*
			* Not part of courses.

4

THE PRESENT POSITION OF CARDIAC SURGERY

by
Sir Russell C. Brock, M.S., F.R.C.S., F.R.A.C.S., F.A.C.S.
Surgeon, Guy's Hospital and Brompton Hospital

IT FALLS TO me to-day to deliver the 75th Bradshaw Lecture, one of the very important lectures of this Royal College, and I first of all express my appreciation of the great honour accorded me by the President and Council in appointing me as lecturer.

It is not necessary for me to say much about William Wood Bradshaw because a full account was contained in the last Bradshaw Lecture delivered by Mr. Lawrence Abel. Bradshaw was born in 1801 and died in 1866 ; he became a Fellow, by election, in 1854 and spent most of his working life in Reading. The Lecture was founded and endowed by Mrs. Bradshaw in 1880.

It seems to have been the custom of the Bradshaw lecturer to take as his subject that aspect of surgery with which he has been most associated. He makes, as it were, an apologia for his surgical life. I propose to do the same and must inevitably speak to you on the surgery of the heart.

When I chose this subject I was tempted to present the newer and more complex details of policy and technique such as the types and detailed treatment of pulmonary stenosis, a subject of particular interest to me. I decided that this would be wrong. I conceive it to be the duty of the Bradshaw lecturer to remember the very general interests of the greater number of his listeners. I feel that I should try to fit cardiac surgery into the general pattern of surgery so that many may understand that this seeming super-speciality is really governed by the same principles with which all general surgeons are familiar. I am afraid, therefore, I shall disappoint any in my audience who expect a very up-to-date and detailed presentation.

Bradshaw, of course, knew nothing about the surgery of the heart, an organ that was in his time still considered to be untouchable. Amongst the seventy-four previous lectures, however, we find one delivered on 11th December 1919 by Sir Charles Ballance on " The Surgery of the Heart." Most of the lecture is taken up with the early history of heart surgery and the change from fear of the heart to a realization that it could be operated on in the same way as other organs. I commend this lecture to anyone interested in the early history of heart surgery ; I cannot today include more than a brief reference to this very fascinating aspect of my subject.

In reading Ballance's lecture one is impressed that it contains little different from what would have been written in 1947. Ten years ago the

213

chief addition would have been inclusion of the successful removal of more numerous foreign bodies from within the heart, chiefly due to the brilliant work of Harken in the Second World War who reported the removal of eleven missiles with no mortality. It is only within the last ten years that the flower of modern cardiac surgery has unfolded to allow a very different story to be told in 1957.

Another thing in Ballance's lecture which impressed me much was his insistence on following the general principles of surgery in dealing with the heart.

Thus he writes, " I do not doubt that the surgery of the heart will occupy in the coming time a conspicuous place in surgical practice. The reward of success will attend our efforts in so far as the heart is treated as one of the ordinary tissues of the body and the method of operation conforms to the fundamental principles of surgery."

I read these words with great pleasure because they contain a principle that has guided me throughout my work and teaching in heart surgery and because I rejoiced to find that the wisdom and perspicacity of Ballance's words have been fully justified by the events of the last ten years.

The untouchability of the heart

The progress of heart surgery was long held back by fear of the heart's intolerance of interference. Billroth's unwise remark in 1883 has often been quoted, that " the surgeon who should attempt to suture a wound of the heart would lose the respect of his colleagues." Only thirteen years later, in 1896, Rehn reported the first successful suture of a heart wound. Since then many hundreds have been thus treated. As Ballance emphasizes, the tissues of the heart must respond to trauma in the same way as other tissues in the body. The superstition which held up progress for so long is well shown by the observations of the great Ambrose Paré who wrote in 1691, " The heart is the chief mansion of the soul, the organ of the vital faculty, the beginning of Life, the fountain of the vital spirits and so consequently the continual nourisher of the vital Heat, the first to live and the last to die.

In spite of this almost lyrical description by Paré it is perhaps sad to think that the heart is really none of these things. It is just a pump, and as a pump we must consider it when we plan to operate upon it.

After the superstition of the untouchability of the heart had been shown to be false, progress in cardiac surgery, after a brilliant start, slowed and virtually came to a full stop except for some slight advance during each of the two world wars. The reason for this was that the time was not yet ripe. The thorax was still a difficult field for the surgeon. Between the two great wars intrathoracic techniques expanded quickly, aided by advances in anaesthesia. By the end of the Second World War the stage was set, the actors were ready and the great drama of the rapid unfolding of successful intracardiac surgery began. Within a few years it had become established as a great addition to surgical treatment and is being

214

used more and more. The drama of this somewhat spectacular field of surgery tends to persist even to-day, but it would be a great mistake to allow this and its rapid development to blind us to its essential practical value. Its rapid success rests on its achievements. It is a part of standard everyday surgery to-day just as is the surgery of the other important viscera.

Incisions for exposure of the heart

Much of the Bradshaw Lecture for 1919 is taken up with an elaborate account of the numerous, often complicated and usually mutilating incisions supposed to be necessary to expose the heart. Particularly undesirable are the various " trap-door " types of approach which were often used until quite recently, although happily rarely now. It is to be hoped that even the resection of a single rib will be generally recognized as the undesirable step that it is.

I find that an adequate exposure for many operations is given by a simple left anterolateral incision with the patient lying on the right side and rotated backwards some 45degs. The curved inframammary incision divides latissimus dorsi only enough to expose the posterior margin of the serratus anterior. This muscle is then divided at its origin to expose the fifth rib for its whole length when the scapula is retracted. The periosteum is stripped from the lower border to expose the rib bed and this is incised to open the pleura.

For closed operations upon Fallot's tetralogy or pulmonary valvar stenosis a simple anterior inframammary incision is to be preferred, made with the patient lying on the back. The pectoral muscle is cut at its origin and the chest is entered through the bed of the fourth rib. If more room is needed a costal cartilage may be divided or the sternum may be cut transversely.

Since the advent of open heart surgery wide and free exposure is needed and a bilateral inframammary incision is often used. After division of the pectoral muscles at their origin the chest is entered through the bed of the fourth rib on each side with transverse division of the sternum. For certain operations such as open aortic or pulmonary valvotomy, the third rib bed may be used on one side and the fourth or fifth on the other side with a step division of the sternum. Some surgeons prefer vertical division of the sternum.

These simple incisions are now virtually standard, give excellent access, and when closed leave no deformity or disability.

The therapeutic problems in cardiac surgery

As it is impossible to deal in detail with all aspects of heart surgery I propose to consider the basic principles which should guide us in the surgical treatment of heart disease; namely what can the surgeon offer and what should determine the need for operation ? Briefly the surgeon can now offer two things ; the relief of an obstruction and the closure of a

215

fistulous communication between the two sides of the heart or between chambers or vessels. The surgeon's ability to help would be greatly extended if he were also able to correct valvar regurgitation. Unhappily, so far, no really satisfactory solution to this problem has been found.

If we consider the relief of an obstruction and the closure of a fistula it will be seen that cardiac surgery begins to fit into the general pattern of much of the surgery of the rest of the body.

The basic functions of a surgeon are simple and mostly date back two or three millennia. They include the control of haemorrhage, the care of wounds, the mending of fractures, the drainage of abscesses and the relief of obstruction. It is this last function which plays such an important part in cardiac surgery.

Until the advent of anaesthesia and aseptic surgery the ability to relieve obstruction of most viscera was limited. Hence it is in the last seventy-five years, during which abdominal surgery has been able to develop, that we have seen the elaboration of the surgery of obstruction and we now know a great deal about the guiding principles. We know, for example, that the sooner an obstruction is relieved the better the result and the lower is the mortality and morbidity.

The need for relief of obstruction of the oesophagus, the stomach, the intestine, the urinary or biliary apparatus is accepted without question as a surgical matter. The heart, for all its poetical aggrandisement, is nothing but another hollow muscular viscus whose function is to receive a substance and to pass it onwards efficiently. The only exceptional feature is that it is equipped in a more complex manner with valves as a circulatory pump. This comparison of the heart with the other hollow muscular viscera from a therapeutic standpoint is simple but is still novel to some who seem to resent it.

Neglect or a casual attitude towards chronic or subacute obstruction of the bladder or colon would be considered professional incompetence or neglect and yet chronic or subacute obstruction of one of the heart chambers is still often viewed with complacency. In recent years the acceptance of the need for the relief of an obstruction has extended to the mitral valve and to the pulmonary outflow tract, but it is less appreciated in relation to the aortic outflow. Aortic stenosis is still seldom approached in the therapeutic sense as a condition of obstruction of the left ventricle. Yet this is exactly what it is and it demands relief even more critically than does obstruction of the less romantic organs such as the bladder and colon.

The left ventricle is the most important muscular structure in the body; it is possible to live, and live well, without a bladder or colon, but not without a left ventricle. The left ventricle is the willing horse; it will go on month after month, year after year, doing its job under the severest burden and with little complaint. When at last it begins to complain, when symptoms are insistent, it is dangerously near its end. It will continue

but a few months or a year or two once the features of failure have appeared ; it is liable to stop suddenly, just as the horse may struggle on until it drops dead. The principle that should guide us in the management of a case of aortic stenosis is to recognize and respect left ventricular obstruction and to relieve it much earlier than is now done.

In the world of literature much discussion centres round the type of operation that should be done for aortic stenosis ; what route or what technique should be employed. These are important but a far greater need at the present time is insistence on the need for operation in many patients who are not having any sort of operation offered them.

The other basic function we are concerned with is the closure of a fistulous communication. The need for closure of a peripheral arterio-venous fistula is universally accepted in virtue of the harmful effect on the heart of the great amount of extra, fruitless work it is called upon to undertake and which sooner or later leads to its failure.

The same applies to a centrally situated fistula. The position has been completely won in regard to persistent ductus arteriosus. The need for its closure is generally accepted unless secondary sclerotic changes in the pulmonary circulation have already occurred, or unless it is compensatory to another lesion.

The two important parallel conditions within the heart are atrial septal defect and ventricular septal defect. Arguments are still heard as to whether or not such fistulous openings should be closed by operation, especially if they are giving rise to no symptoms.

These defects, unless very small, impose a great and unnecessary strain upon the heart. Blood is pumped around the pulmonary circulation in an extravagant and harmful manner. The heart is thus called upon to do a constant extra amount of unnecessary work. The lung vessels are exposed to an enormous extra strain for which they are not designed and consequently they resist, become sclerosed and eventually constitute an unendurable obstruction to the emptying of the right ventricle.

This factor of obstruction, added to simple overwork from excessive flow, is commonly the final cause of heart failure and death. The situation can be resolved into its simplest form in persistent ductus arteriosus. Few patients with this condition reach middle age but from time to time one sees patients in the forties or fifties with a persistent ductus and who are found to have a large pulmonary flow but little, if any, rise in pul-monary vascular resistance. They are usually in heart failure due to fatigue of the left ventricle which has been working against the large arteriovenous leak. Closure of the ductus usually controls the failure because it at once corrects the overwork of the left ventricle. But if such a patient is in failure from a high pulmonary resistance death is much more likely to follow operation, for the resistance almost certainly does not lessen when the ductus is closed ; the heart still has to beat against the equivalent of an obstruction, just as serious as a valvar obstruction. It is the development

of this high resistance which usually causes death much earlier n life. Surgery, therefore, aims to close a central fistula as early as poss ble to prevent the development of this dangerous secondary vascular obstr ction. It occurs soonest and in its severest form in ventricular septal defect which is why this lesion is so dangerous to life. In atrial septal defect it may also add greatly to the hazards of operation.

It is difficult to understand the excuse for non-intervention that the patient is suffering no symptoms. There may be other and worthier grounds for non-intervention but this is no good reason. A layman may protest that no treatment is necessary if no symptoms are present, but for a trained medical man to support such an argument denies the many years spent in training as a doctor and the many more years in training as a specialist if at the end we only advance the arguments of a layman. It is our duty to assess the disturbance of the patient's basic physiology even in the absence of overt symptoms. This is the very reason for our existence as trained doctors.

The estimation of mechanical disability

Advice about the need for operation on the heart is still too often largely empiric. It is necessary to consider how much nearer we can get to accurate assessment to-day. It may be said that this is not a matter of surgery, that this is the function of the physician. In such a matter medicine and surgery are inseparable.

The subject cannot be considered in detail but some simple arguments may be useful. We should remember that a pump such as the heart has a dual function. It receives blood and it passes it on ; it has an intake and an output. Its output must be enough for all the varying phases of rest and activity, but at the same time it must deal efficiently with the blood reaching it. For example, the output may be adequate and there may be no features of a diminished circulation either systemic or pulmonary, but in order to achieve and maintain this adequate output the heart may be working under a continual strain. Typically such a strain is imposed by an obstruction or by a fistula. If we rely solely upon the adequate output we can be badly misled ; there may be no features, subjective or objective, of a lowered output, especially in young people. If we seek to assess the strain imposed upon the heart in maintaining this adequate output then we approach nearer to being able to give rational advice. This assessment may be made by simple clinical methods ; more often, however, some additional investigations are needed.

To make my meaning clearer let us consider a parallel with a man in a leaking boat who is baling out water.

If the leak is small he can easily bale out water as it collects ; he is in no danger (Fig. 1a).

If the leak increases he can readily increase his output by baling more vigorously and still no water collects (Fig. 1b).

The leak increases still more ; he bales more strongly, no water collects, the boat still floats. You might say that all is well ; his output is good, there are no symptoms.
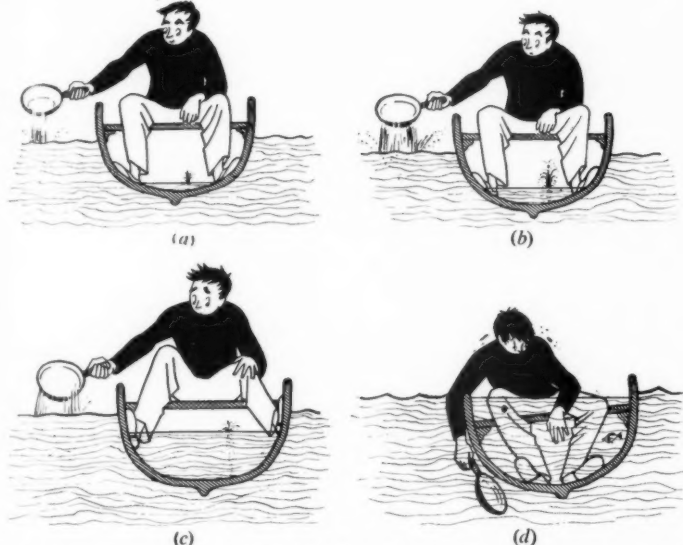
Fig. 1. Diagram of the onset of cardiac distress. For explanation, see text.

However, he will soon begin to tire and, although his output is still high water begins to accumulate in the boat. From outside all appears well, but look inside the boat and there is a pool of water slowly increasing (Fig. 1c). All is not well. He soon shows signs of fatigue, his output falls, the water level rises and disaster is in sight. This is doubtless preceded by a sharp further fall in his ability to bale out ; the boat soon floods and sinks (Fig. 1d).

If his ability to bale is poor, that is his output is inadequate, it may be obvious at first glance that unless he receives help he is going to sink. This situation presents no difficulty ; we are more concerned in assessing the need for help for the man who is apparently holding his own.

A simple clinical parallel is the man who has some degree of bladder obstruction. His stream and output appear good but concealed from direct observation is the bladder which, in order to achieve this apparent satisfactory emptying, may already be under considerable strain, a strain which is also felt in the pelves of the kidneys and thence in the smaller secretory units with even more serious secondary effects. It is up to us to assess the degree of urinary obstruction before it is obvious that the output is failing. It is up to us to assess the same in the case of the heart.

219

In aortic stenosis the obstruction to the emptying of the left ventricle is followed by hypertrophy of the muscle; all may appear well; output is normal. But at what price? That is what we need to know. What is the cost to the reserve of the left ventricle? Or in pulmonary stenosis, what is the cost to the muscle power and reserve of the right ventricle? These two, the ventricular muscle masses, are in the final count what we depend on for life.

It may be said that compensation occurs. That nature endows us with ample reserve of power and the ability to increase the strength of the ventricular musculature to overcome such a load. Why worry too much? I would warn you against this mirage of " compensation." If the strain is small, reserve is not encroached upon and there is no need for anxiety. But if the strain is significant then ultimately we must pay for this compensation just as we must pay a price for everything. The price is damage to the ventricular muscle; damage which eventually becomes permanent, irreversible and precedes failure. This happens even in the young, even in children, even though in them the basic reserve is initially greater. The very strength of the muscle in the young tends to encompass its own end because its power allows it to carry on until the brink of failure. The huge ventricle which shows so much of this " compensatory " hypertrophy is never a healthy mass of muscle deserving our admiration. It is poor stuff, deserving our sorrow and regret.
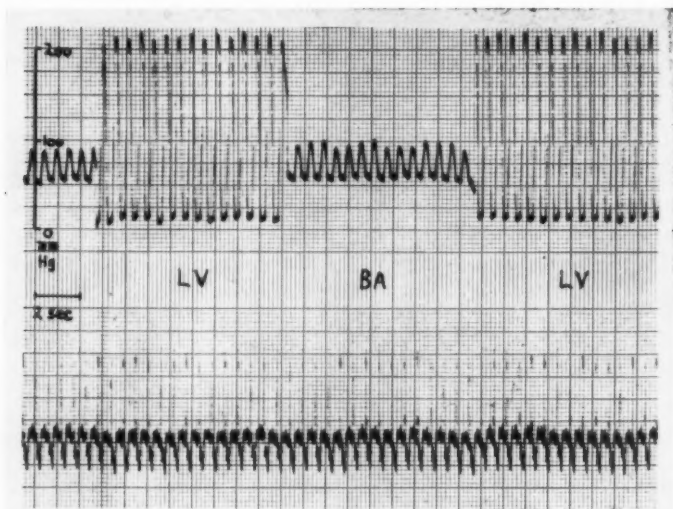
Fig. 2. Electromanometer tracings of pressure in the brachial artery and in the left ventricle to show severe aortic stenosis.

It is therefore imperative for us to try to assess the burden, the strain, which the ventricles are carrying. Then we can with greater confidence and with greater sense advise on the need for operation. Basically all our investigations, clinically and by the various laboratory techniques, are directed to this end, unless it is already obvious that failure has occurred.

Let us take the example of a patient with aortic valvar stenosis who may be symptomless and may have an apparently normal cardiac output. Perhaps he is a child ; perhaps a married man in the twenties doing full work. We need to look beyond the façade ; we need to consider what strain the left ventricle is enduring in order to maintain this output, this symptomless state. To wait until it begins to complain, to give rise to symptoms, is to-day ignorant and even contemptible. And yet this is still often the usual mode of management.

When straight clinical examination does not help we find the first information of value is given by the electrocardiogram, especially when a strain pattern begins to emerge under observation. Great help to-day is provided by the information obtained from left ventricular puncture
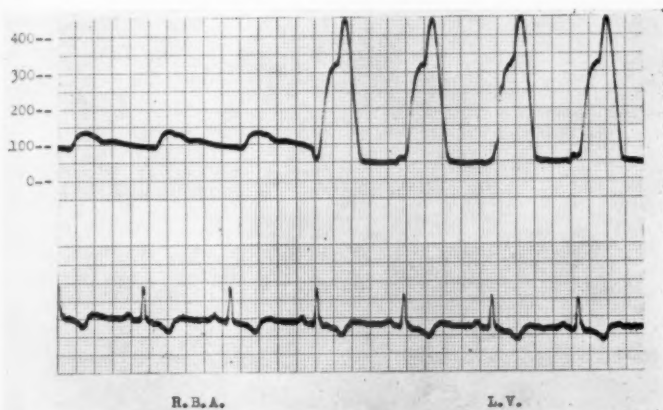
Fig. 3. Tracing obtained by percutaneous left ventricular puncture to show a pressure in the left ventricle of 450 mm. Hg.

which gives us the pressure to which the left ventricle is exposed while it maintains the cardiac output which can, if necessary, also be measured (Fig. 2). The pressure in the brachial artery may be relatively normal, i.e., 120/80 mm. Hg., but the systolic pressure in the left ventricle may be 250 or 300 mm. Hg. ; clearly such a strain should not be permitted to continue unrelieved. We have even recorded a left ventricular pressure of 450 mm. Hg. (Fig. 3).

Percutaneous left ventricular puncture is a simple procedure and in more than 100 cases in which it has been used at Guy's and the Brompton

221

Hospital (in which places it originated) there has been no trouble until recently when a death occurred. It is accepted throughout the world as a safe and valuable procedure (Figs. 4 and 5).

There is often a simple correlation in pure aortic stenosis between the electrocardiographic changes and the height of the ventricular pressure. Thus a strain pattern with T inversion and ST depression in V4-V6 suggests there will be a pressure gradient across the aortic valve of between

(a)   (b)
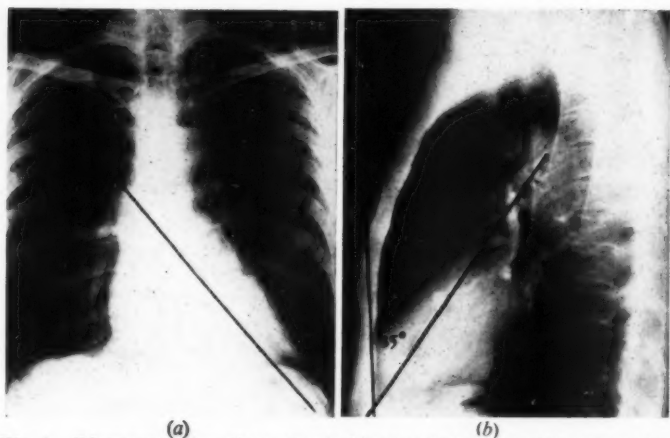
Fig. 4. Diagrams to show the anatomical landmarks in left ventricular puncture. In the frontal plane (a) the line of puncture extends from the apex to the junction of the second right costal cartilage and the sternum. In the lateral view (b) the needle is directed backwards at an angle of about 30 deg.

(c)   (d)
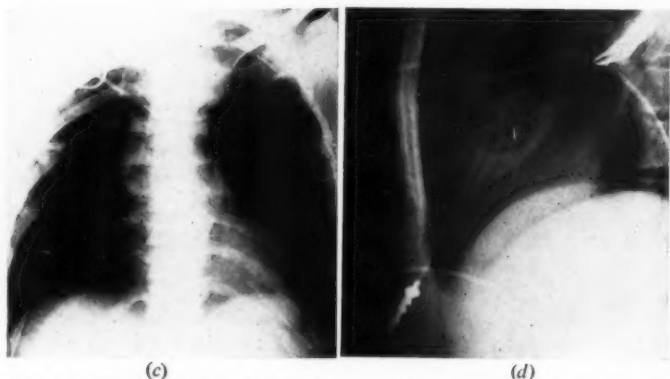
Fig. 5. Radiographs taken during left ventricular puncture to show the actual needle in place. Note in (b), the lateral view, the needle points exactly at the calcified aortic valve, confirming that it is in the true axis of the left ventricular cavity.

222

100 and 150 mm. Hg. The same applies to right ventricular obstruction in which electrocardiographic strain changes in V1-V4 will be usually found associated with a right ventricular pressure of 150 to 200 mm. Hg. (ten times the normal).

Conversely the absence of an important gradient across the aortic valve indicates that obstruction is not severe and that the cause for any symptoms or disability must be sought elsewhere ; for instance, myocardial factors may be responsible.

When we have information of this sort about a cardiac case we can give advice with confidence, without guessing. We can be as sure of our ground as if we have obtained a positive biopsy of malignant disease in a previously obscure case.

There is, of course, one very good reason for not advising an operation for the relief of an obstruction or the closure of a fistula within the heart, namely, that the operative risk is disproportionately severe ; that the patient stands to lose more by the attempt to correct the fault than by leaving it alone. This argument cannot be denied.

The next logical step is, therefore, to consider what surgery can offer in the correction of the basic lesions we have been discussing.

Mitral stenosis

More than thirty years have passed since the first attempts were made to relieve mitral stenosis by operation. In the early 1920s much work was being done in the United States. To Sir Henry Souttar belongs the credit of having, in 1925, introduced the technical step of digital exploration of the mitral valve through the atrial appendage. After Souttar's single case a long silence fell and it was not until 1948 that mitral valvotomy, as we know it to-day, became established simultaneously in this country and in the United States. The fundamental method remains ; relatively minor and often individual variations of technique alone have been added. The success of the operation is testified by the thousands of patients in clinics in almost all countries throughout the world who have been saved by it from disability or death. It is now firmly established as one of the great operations of surgery, holding as important a place as gastrectomy or cholecystectomy.

This is not the occasion to discuss it more fully. It can only be said that in properly selected cases at a favourable stage of the disease the mortality of operation is low, less than 1 percent. ; when the valve is not too damaged by severe disease the functional result is good and lasting. In more severe cases, especially when progression has occurred to chronic heart failure due to long continued unrelieved obstruction, the risk is inevitably higher. In the group with severe, high pulmonary resistance and chronic failure, the mortality may be as high as 25 to 30 per cent. Here we are not operating for mitral stenosis but for unrelieved severe heart failure. Even

223

then the survivors represent pure salvage, previously lost without operation.

The average mortality of mitral valvotomy should be less than 5 per cent. The results should be good in fully 70 per cent. of cases.

I must leave untouched the problem of re-stenosis.

Aortic stenosis

I have already referred to the problem of aortic stenosis ; that it should be considered as an obstruction of the left ventricle and the need for its relief by operation assessed far more critically than has been the case. Opinion seems almost hypnotized by the calcified state of the valve which is so often present ; an extraordinary attitude of hopelessness seems to have grown up in many places about the condition.

The aortic valve is inseparable from the left ventricle ; it is not an isolated anatomical structure. If we stopped looking at the valve and instead focused our attention upon the gravity of the unrelieved left ventricular obstruction we would be more firm in advising valvotomy rather than wasting time through indecision. Enough patients have now been operated upon with good results to dispel fears and lack of confidence. No-one can expect to restore perfect or even good function to a severely calcified and deformed valve but at any rate the greater part of the burden of chronic obstruction can be relieved and a reasonable improvement obtained. We must be content with a somewhat limited objective.

My own figures are as follows :

AORTIC VALVOTOMY

Total	..	..	..	..	..	101	
Died	..	..	..	..	..	17	(17 per cent.)
If exclude first seven operations :							
Died	..	..	..	..	..	12	(12 per cent.)

Table I. The mortality of transventricular aortic valvotomy.

AORTIC VALVOTOMY
Results

Surviving	..	..	..	..	..	84	
Good result		..	..	..	..	60	(70 per cent.)
Fair result	..	..	..	..	..	13	(16 per cent.)
Died since	..	..	..	..	..	11	

Table II. The clinical results of aortic valvotomy.

These show that operation is fully justified.

When the valve is severely calcified and the patient is beyond middle-age or in poor condition, my own preference is for closed transventricular operation. This is well tolerated and the whole subject has been fully discussed elsewhere (Brock, 1957). When the valve is not calcified (usually below the age of thirty), or when it is only moderately calcified in patients up to about forty-five, I prefer open aortic valvotomy using hypothermia to enable the circulation to be arrested for the requisite five to six minutes. At present I feel that open operation in older or in

poor risk patients may carry an unduly high mortality although this remains to be shown by actual figures as yet not available.

I have for several years made a routine of measuring the pressure in the left ventricle and aorta at operation before and after valvotomy, just as I also do in the right ventricle and pulmonary artery in pulmonary stenosis. This policy of complete study of aortic obstruction enabled us a few years ago to recognise during life the first examples of congenital subvalvar aortic stenosis (Brock and Fleming, 1956), a condition previously verifiable only at autopsy. So far I have now encountered fifteen examples of this condition surgically.

We have recently been able to extend percutaneously left ventricular puncture by passing a fine nylon catheter up into the aorta through the needle in the ventricle. In this way a withdrawal pressure record is obtained and allows us now to make the diagnosis of subvalvar stenosis before operation (Fig. 6).
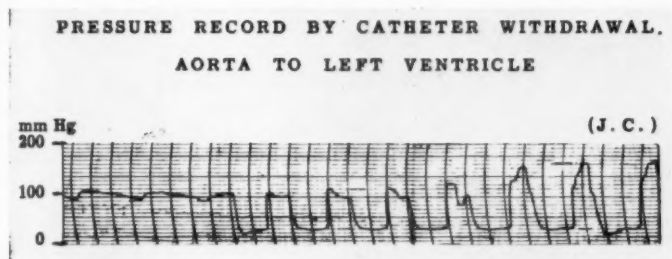
Fig. 6. Pressure withdrawal record taken at left ventricular puncture and revealing that an aortic subvalvar stenosis is present. Note that as the valve is traversed the systolic pressure is the same but the diastolic pressure drops to that in the ventricle.

More recently still this policy has enabled us to recognize the hitherto unrecorded condition of functional subvalvar aortic stenosis (functional ventricular obstruction) which may complicate left ventricular hypertrophy from various causes (Brock, 1957). It is important to recognize this condition because if operation is done for presumed organic valvar stenosis death follows at once.

PULMONARY STENOSIS

This complex subject can be touched on only lightly here.

Pulmonary valvar stenosis with normal aortic root

There is no difference of opinion on the need for relief of the obstruction, i.e., valvotomy, in these cases. The only difference of opinion is whether open valvotomy is needed rather than closed valvotomy.

The closed or transventricular operation has been used since 1948 and with substantial success. The mortality is ordinarily low (some 5 per cent.)

225

PRESSURE RECORDS BY CATHETER WITHDRAWAL AT OPERATION

P. A. to INFUNDIBULUM : to R. V.
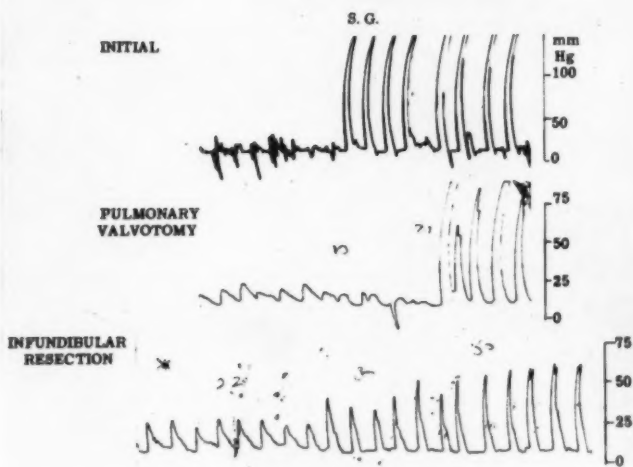
Fig. 7. Pressure withdrawal records taken at open operation for pulmonary stenosis. In the top (initial) tracing the pressure change occurs at valve level. The middle tracing was taken after open valvotomy ; the residual high gradient occurs at infundibular level. The lowest tracing shows that after open infundibular resection the gradient is almost obliterated.
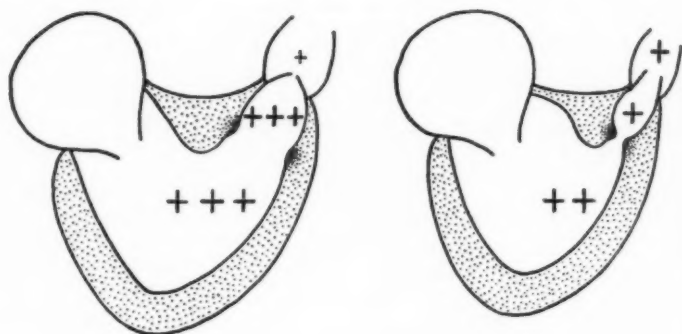
Fig. 8. Diagram to show the mode of development of secondary infundibular stenosis after effective pulmonary valvotomy.

226

and the results are good ; many dramatic cures have been achieved. In some the fall in pressure in the right ventricle is disappointing, indicating that the stenosis has been insufficiently relieved. For this reason in particular open operation has been advocated to ensure an adequate valvotomy.

Apart from this, open valvotomy appeals because it is in conformity with the inevitable development of cardiac surgery towards open, definitive operations in place of closed procedures. So far no substantial series of open pulmonary valvotomies has been published but my own small experience of twenty-five cases with one death indicates the mortality

PULMONARY VALVOTOMY

Total	..	..	..	..	133	
Closed valvotomy..		..	..	..	108	(14 died)
Open valvotomy	..	..	..	..	25	(1 died)
Total deaths	..	..	..	..	15	(11.4 per cent.)
But 9 in last 128	..	..	..	..		(7 per cent.)
Cyanotic	..	..	..	..	62	
Died	..	..	..	..	11	
Acyanotic	..	..	..	..	71	
Died	..	..	..	..	4	

Table III.   The results of pulmonary valvotomy.

need not be high. The actual valvotomy is done by opening the pulmonary trunk to expose the valve. For this purpose it is necessary to arrest the circulation for some four to five minutes and this can be done comfortably under hypothermia even though many surgeons use a total heart-lung by-pass.

The situation is, however, not so easy as would appear ; it is found that even after an open valvotomy which has been complete, the pressure in the right ventricle may still be as high as ever. The explanation of this lies in the development of an infundibular, i.e., subvalvar, stenosis as is shown by a pressure withdrawal record (Fig. 7). The mechanism of production is explained in the diagrams in Figure 8 ; it will be seen that as the valve stenosis is relieved and the right ventricle is partly decompressed the walls of the infundibulum come together in systole and cause a secondary obstruction. If a degree of fibrous (congenital) infundibular stenosis is present, as may be the case, the explanation is easy. Such a secondary stenosis can also occur even in the absence of a fibrous infundibular stenosis. The stenosis may be entirely functional and is due to gross right ventricular hypertrophy ; the ventricle is, as it were, muscle bound. This is another result of the policy of continued expectancy, of leaving a stenosis unrelieved over many years, often just because the patient is a child and has no symptoms. The tragedy is that the condition may have become inoperable ; it often demands a ventriculotomy for its relief, additional to the open valvotomy.

The possible need for open relief of a secondary infundibular stenosis is a much greater argument in favour of a routine open operation for pulmonary valvar stenosis rather than the plea that a closed valvotomy may be a technical failure.

227

The occurrence of secondary infundibular stenosis is illustrat d in Table IV ; Table V shows its relief by a simultaneous open infundibular resection.

	P.A.	R. V.
Initial pressure..	13	167/23
Final pressure	12/9	151/15
Initial pressure..	20/10	85/10
Final pressure	20/17	70/5

Table IV. Pressure readings in the pulmonary artery and right ventricle in two cases of pulmonary valvotomy. In both, in spite of an adequate valvotomy, there has been no significant improvement in pressures.

	P.A.	R.V.
Initial pressure..	34/18	135/8
After open valvotomy	23/10	120/10
After open infundibular resection ..	18/12	28/6

Table V. Pressure readings to show that a residual high ventricular pressure after pulmonary valvotomy may be corrected by infundibular resection.

Unfortunately even a wide infundibular resection may fail to relieve the secondary functional infundibular stenosis as is shown by Table VI. The thick ventricle continues to be obstructed and our only hope is that

	P.A.	R.V.
Initial pressure..	18/0	150/0
After open valvotomy	25/10	170/0
After open infundibular resection ..	30/15	160/0

Table VI. Pressure readings to show that in some advanced cases even infundibular resection fails to lower the high right ventricular pressure.

as the months pass the gross muscular hypertrophy may regress sufficiently to set up a benign circle of diminution of stenosis, further muscle regression and so on. That this can occur on occasions when only valvotomy has been done and the infundibular stenosis has been left untouched is shown

	P.A.	R.V.
Before valvotomy	16/0	180/20
After valvotomy	23/10	120/10
After infundibular resection	18/10	110/12
18 months later	23/11	25/—1

Table VII. Pressure readings to show that the high residual right ventricular pressure after valvotomy and infundibular resection may correct itself over a period of time as the muscular hypertrophy recedes.

by Table VII. It is often unsafe to rely upon this and in most cases the ventricle should be opened and the subvalvar region resected. Unhappily,

228

as mentioned above, in some patients the condition may already be inoperable.

Pure infundibular stenosis

This condition is uncommon but must be differentiated from pulmonary valvar stenosis. The obstruction is fibrous or fibromuscular and lies some 1 to 4 cm. below the valve. Absence of post-stenotic dilatation of the pulmonary trunk, as seen in valvar stenosis, should suggest the diagnosis. An infundibular chamber may also be identified by plain radiography, by angiocardiography or by catheterization.

Although the stenosis can be punched away by a closed or blind technique, this should not be done owing to the risk of cutting the tendons controlling the septal leaf of the tricuspid valve which arise close to the stricture. An open operation can be done under hypothermia or heart-lung by-pass and the tendons are then easily avoided, and the stenosis can be completely excised.

Fallot's tetralogy

This rather special form of pulmonary stenosis is characterized by the presence of a ventricular septal defect which allows shunting of blood from the right ventricle to the aorta. It forms some 75 per cent. of all cases of cyanotic congenital heart disease. The stenosis may be valvar or infundibular or both combined.

Considerable difference of opinion exists as to the best treatment, in contrast to pulmonary valvar stenosis without a ventricular septal defect in which all are agreed the obstruction of the right ventricle must be relieved. In the Fallot group some suggest that the presence of the ventricular septal defect alters the situation so much that the stenosis may be ignored and a short-circuiting procedure done to direct back to the lungs the mixed venous and arterial blood that has entered the aorta from the right ventricle.

This is the basis of the Blalock-Taussig operation in which a branch of the aorta (usually the subclavian artery) is anastomosed to a pulmonary artery. Potts has modified this to join the aorta itself to a pulmonary artery.

The Blalock procedure was introduced in 1945 at a time when no direct operations upon the heart were being done. Its success was immediate, brilliant and fully deserved. It has been performed in thousands of cases throughout the world and has given excellent results. Its popularity continues.

In spite of this we must consider the basis of these anastomotic procedures against the whole background of cardiac surgery, having regard especially to the principle enunciated earlier about the relief of obstruction. There is also the historical background ; what sufficed in 1947 must be viewed differently in 1957, now that we are able to afford direct relief to

229

many intracardiac lesions. It is doubtful, for example, if the short circuiting procedures would be put forward to-day as primary treatment for Fallot's tetralogy.

By operating on the pulmonary stenosis itself we follow a good principle of relieving an obstruction, we improve the blood flow to the lungs and at the same time we correct the tendency for the previously obstructed right ventricle to empty into the aorta through the septal defect ; in other words we also correct the shunt (Fig. 9). If the pulmonary stenosis is
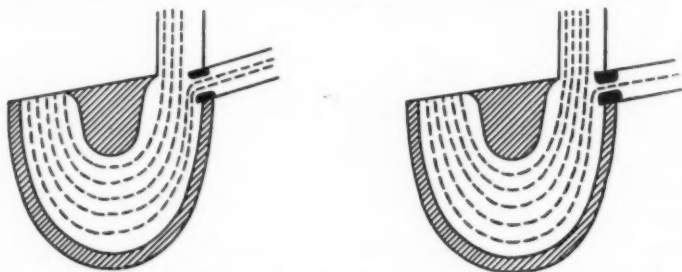
Fig. 9. Diagram to show how, after relief of a pulmonary stenosis (on the left), not only does more blood go to the lungs, but a correspondingly smaller amount of blood is shunted through the ventricular septal defect into the aorta.

lessened just the right amount, a nice balance is achieved by which cyanosis and disability are corrected and yet the pulmonary flow is not excessive ; some stenosis must be left to protect the lungs so long as the septal defect remains open.

It has in the past been objected that operation on the pulmonary stenosis is anatomically unsound ; that it is too difficult ; that the mortality is too high. These objections are seldom heard to-day and have been shown to be wrong by the high proportion of good results obtained without a high mortality.

One great advantage of the relief of the stenosis is that the right ventricular outflow tract and the pulmonary arteries are enabled to grow with the patient. If the outflow tract is merely short circuited it does not grow larger, in fact the stenosis becomes steadily more severe through daily wear and tear from the passage of blood until eventually the obstruction is nearly complete and life depends on the continuance of the artificial ductus. It is unfortunately only too common for this to become inadequate or to close completely, even after years of satisfactory function.

It is very disturbing to see the severely ill patients in whom an anastomosis has failed. They are usually very cyanosed and disabled, very polycythaemic and present a dreadful surgical problem. The actual technical difficulties of re-operation are severe, but even more serious is the liability to uncontrollable haemorrhage due to a fibrinolytic process which does not seem to respond to treatment. Many of the " failed "

anastomotic cases are frankly inoperable and I fear that we shall see them in increasing numbers.

I have recently compared the results of the anastomotic procedures I have done since 1949 with the results of the direct operations over a comparable time. These are shown in Tables VIII and IX. I emphasise they do not include operations for pulmonary atresia or tricuspid atresia nor re-do operations.

BLALOCK'S ANASTOMOSIS

Total	106	
Died after operation	14	(14 per cent.)
Died since ..	18	(32 per cent.)
Survived ..	92	
Have had second operation	14	
Need second operation ..	10	
	24	(26 per cent.)

RESULT

	Initial		Now	
Good	81	(76·5 per cent.)	41	(40 per cent.)
Fair	5		11	
Poor	6		17	
Not traced			5	
Cerebral lesion			12	
S.B.E.			4	

Table VIII. Follow-up of 106 cases of Blalock's anastomosis for Fallot's tetralogy.

DIRECT OPERATIONS

Total	106	
Died from operation	16	(15 per cent.)
Died since ..	2	(17 per cent.)
Survived ..	90	
Have had second operation	7	
Need second operation ..	5	
	12	(13 per cent.)

RESULT

	Initial		Now	
Good	78	(73 per cent.)	68	(64 per cent.)
Fair	12		6	
Poor	1		11	
Cerebral lesion			1	
S.B.E.			1	

Table IX. Follow-up of 106 cases of direct relief of the pulmonary stenosis in Fallot's tetralogy (Brock's operation).

It will be seen that the alleged high mortality of the direct procedures is not correct; the final mortality of 17 per cent. contrasts with the final mortality of 32 per cent. for the anastomotic operations. Whereas the initial good results after the direct procedures are substantially maintained there is a steady falling off in the indirect group so that instead of the result being good in 76 per cent. it is now good in only 40 per cent. A second operation has been necessary in 26 per cent. in contrast to 13 per cent. in the direct group.

Of great significance is the observation that a cerebral lesion (abscess or thrombosis) occurred in twelve out of ninety-two after an anastomotic

operation, whereas it occurred only once after the direct operation. In this case the stenosis had been imperfectly relieved. This shows unequivocally that if the stenosis is left untouched peripheral systemic emboli are easily directed from the right ventricle into the aorta and so to the brain. When the stenosis has been relieved and the shunt into the aorta corrected the venous blood is filtered by the lungs.

The relief of the pulmonary stenosis by a closed operation is only partly corrective. The ventricular septal defect, i.e., the internal fistula, remains and this constitutes a potential menace to life and health in virtue of the constant strain to which the right ventricle is exposed seeing that it has to beat against the systemic resistance or alternatively to support an excessive pulmonary flow. Also there is always the possibility of increasing pulmonary resistance.

To-day, however, it is possible to close the ventricular septal defect and so achieve complete correction of the heart lesion. Indeed one of the sound reasons for a direct operation on the pulmonary stenosis is that it paves the way for this final step. It may be an incomplete procedure in itself but it is a logical half-way step, whereas an anastomosis actually hinders any totally corrective procedure.

Total correction of Fallot's tetralogy

It is clearly better to close the septal defect as well as to relieve the stenosis but experience has shown that the earlier hopes that this could be done routinely have so far not been justified. Thus, my own first case of complete correction under total heart-lung by-pass was successful, but then followed several failures, some no doubt due to technical errors or to the hazards of total by-pass, but not all were so explainable. Moreover, the experience of others has been similar, Kirklin at the Mayo Clinic reported a mortality of some 35 per cent. in this group and Lillehei in seventy-one cases had twenty-five deaths, a mortality of 38 per cent. This last was in a series of nearly 400 cases of total by-pass and so can scarcely be accounted for by inexperience in the method.

The explanation for the high mortality lies, with reasonable certainty, in the unsuitability of certain cases of Fallot's tetralogy for one-stage total correction. The pulmonary outflow tract and lung vessels may be too small to carry the increased pulmonary circulation and, in addition, the left ventricle may be unable to carry the whole of the systemic circulation. Death is due to the difficulty of rapid physiological adjustment to the sudden correction of the gross circulatory abnormality.

It is, therefore, doubtful if a one-stage corrective procedure will ever be possible in all cases of Fallot's tetralogy. The answer would seem to lie in selecting certain cases for a two-stage operation. The first step would consist in relieving the stenosis, thus enabling the right ventricular outflow tract and pulmonary vessels to develop and the left ventricle to take on its

fair proportion of work. If it should prove necessary the ventricular septal defect can later be closed by an open operation. It is not yet certain that this will be necessary in all cases.

The decision whether or not a patient is safe for a one-stage procedure may be made before operation if plain radiography and angiocardiography suggest the pulmonary outflow tract and vessels are adequate ; an estimate of the size of the right ventricle, especially by consideration of the electrocardiograms, will also help. The final decision may have to be made at operation when a more critical assessment can be made. For instance, a heart-lung machine will be ready but if circumstances are found unfavourable for a fully corrective one-stage procedure then a simple closed relief of the stenosis can be done.

So long as a total corrective operation carries a mortality of 25 to 35 per cent. it is clear that it cannot be accepted as an operation of choice. I hold no brief for the insertion of an Ivalon " patch " into the outflow tract of the right ventricle, or, worse still, across the pulmonary valve and into the pulmonary trunk as well. This must surely end in disaster ultimately.

This consideration of open heart surgery for closure of the septal defect as well as for open relief of the stenosis inevitably introduces the whole question of open heart surgery. Mention has already been made of open aortic valvotomy, of open pulmonary valvotomy and of open infundibular resection ; it remains now to discuss the methods more fully.

OPEN HEART SURGERY

The great developments of cardiac surgery during much of the last ten years have been achieved by various closed or semi-blind techniques ; they have been in the nature of running repairs. Clearly it is better to operate, if possible, with the lesion fully exposed through an open cardiotomy. This has been the evolution of most cardiac surgical techniques during the last few years and it is remarkable how these open techniques have become possible.

Before discussing the methods themselves we may consider the procedures that demand an open technique. Open aortic and open pulmonary valvotomy have been dealt with as well as open infundibular resection. I prefer an open operation also for tricuspid valve disease. At present the results of closed valvotomy for mitral stenosis are so good that there is but little case for advising the extra perils of an open operation. There is, however, a case for exploration of a regurgitant mitral or aortic valve under direct vision. There are a few other cardiac conditions which demand an open technique but the chief indication is for closure of septal defects.

Atrial septal defect

Various operations have been devised for closure of an atrial septal defect by some closed method of suture.

233

I have personally rejected these external methods in favour of an open operation in accordance with the general principle of the advance of cardiac surgery towards open techniques. The right atrium is opened widely and the defect is closed by direct suture. In the seventy cases in which I have used this method the margins of the defect have always come together without difficulty and it has never been necessary to insert a plastic prosthesis. I cannot reconcile myself to the routine, or near routine, use of such foreign bodies within the heart of a young subject. All our experience indicates that sooner or later disaster will follow their use.

Kirklin (Kirklin, *et al.,* 1956) has published excellent results in closure of atrial septal defect using the " atrial well " technique introduced by Gross. There is a good argument for using this semi-open method at any rate for certain poor risk cases in which it would appear to be better to avoid total circulatory interruption, although I am concerned by the statement that it necessarily involves the use of a plastic prosthesis to close the defect.

In an uncomplicated case the atrial septal defect can be sutured by open operation in some five to eight minutes. During this time the circulation must be arrested by occlusion of the venae cavae. Although many surgeons use total heart-lung by-pass for this there is really no need to do so for with the aid of hypothermia it is possible to arrest the circulation for some ten to twelve minutes without fear of brain damage. Sellors (Bedford, *et al.,* 1957) has recently reported seventy patients operated on under hypothermia with only two deaths. Swan also has had a very low mortality.

I must emphasize that many open cardiac procedures can be performed with precision and safety under hypothermia and without the need for total heart-lung by-pass.

Hypothermia

During the last few years hypothermia has fallen into considerable disuse and is often frankly condemned. I wish to make a plea for its continuance and its wider use. Much of the distrust arises from improper use and from expecting too much from it. For example, people were not content to use it around 30 degs.C., but tried by lowering the temperature several more degrees to secure a longer working time ; this is commonly at the expense of safety. In addition, the advent of total heart-lung by-pass seemed suddenly to be so near that many stopped their hypothermia trials and waited for or flirted with the by-pass.

In hypothermia used at 30 degs.C. we have a safe and valuable method which allows ten minutes for open heart surgery without the extra danger and complexities of the heart-lung machine. During this time it is possible to correct almost all the common lesions except closure of a ventricular septal defect or closure of the " ostium primum " type of atrial septal defect (atrioventricularis communis). For these conditions much more time is needed for safe and accurate work ; in general twenty to sixty

minutes ; too long for hypothermia. If surgeons would make more use of hypothermia they could use open heart surgery at once for many cases and would also gain confidence and experience in the manipulations and techniques of open heart surgery while they are developing their technique with the heart-lung machine.

The commonest method of using hypothermia is by some form of surface cooling. At Guy's we have developed and used with success a method of venovenous blood-stream cooling which we feel has certain great advantages ; my assistant, Mr. D. N. Ross, has done much to establish this (Ross, 1954 *a* and *b* ; Brock and Ross, 1955). By this method the chest is opened at normal temperature, the diagnosis confirmed, and the need for hypothermia verified or decided upon. (For example it may be decided to use a heart-lung machine instead). Catheters are then introduced into the superior and inferior venae cavae and blood is pumped by a simple hand pump through a cooling coil and back into the body (Fig. 10). In this way a certain regulation can be maintained over the rate

Catheter in
S.V.C.

Pump

Cold blood
returned to I.V.C.

Cooling coil
in refrigerant
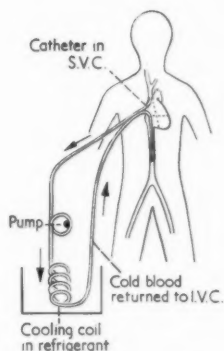
Fig. 10.   Diagram to show the Guy's method of venovenous cooling to induce regulated hypothermia.

of fall of the temperature which is usually about 0·5 degs.C. each five minutes. Heparin is not necessary. At 30 degs.C. the operation is done and at once venovenous warming is begun with the same catheters.

It is often stated that open ventriculotomy is unsafe under hypothermia. We have not found this so on the thirty occasions we have used it.

Total heart-lung by-pass

In total by-pass the work of the heart and the lungs is taken over by a machine. There are nearly as many varieties of machine as there are of motor-cars ; their basic construction is usually partly dictated by sound mechanical and physiological principles ; partly by whim. The proportion of these two components varies widely.

235

In Great Britain the only notable machine evolved has been that of Melrose ; most of his early work was in fact done in this College. To Melrose also we owe the introduction of the valuable step of controlled cardiac arrest in which a potassium citrate solution is injected into the aorta so as to perfuse the coronary vessels. The heart stops in a few moments and remains so for as long as thirty to forty-five minutes if necessary ; the flaccid state greatly facilitates suture of a septal defect. As soon as the artificial circulation is allowed to flood the coronary vessels (by removing the aortic clamp) the potassium is washed away and the heart beats again.

It is fairly certain that the ideal machine for total by-pass has not yet been designed. At present the two most important types are that of Gibbon, as used by Kirklin at the Mayo Clinic, and that of Lillehei and de Wall as used at Minneapolis. There are objections to both, but in my opinion most of the criticisms of the Lillehei-de Wall bubble oxygenator are unsound and often unfair. The large number of cases in which it has been used with success show that it is essentially as safe as the other types. For example, I was recently informed that Lillehei had operated on forty consecutive patients with only one death. It has the great advantage of cheapness and simplicity for it can be assembled for less than £1,000 in contrast to £25,000 or so needed for the Mayo Clinic machine.

So far as my latest information goes the overall mortality of operations using either of these machines is between 25 and 30 per cent. This high mortality must give us pause, but at the same time there is no doubt that nothing can stop the firm establishment of total heart-lung by-pass in cardiac surgery. How long it will be before the technique is in general use is difficult to say but the very rapid developments of the last few years suggest that it will not be long.

Ventricular septal defect

The use of the heart-lung machine is, par excellence, for the closure of ventricular septal defect. This lesion is of such basic importance and is associated with so many heart lesions that cardiac surgery is lacking unless or until it can provide for its safe closure.

The actual technique of closure is sometimes easy, frequently difficult, almost never impossible. Unfortunately the risk of the closure is governed essentially by other matters, notably the presence of increased pulmonary vascular resistance. Operation below the age of two years has been found to be especially dangerous. When the pulmonary resistance is high, the mortality is also high. At present it is only in the good risk cases with a low or only moderate pulmonary resistance that a mortality of 10 to 20 per cent. can be expected. In the bad risk cases the mortality may be well over 50 per cent.

Cooley was recently kind enough to give me his results in 113 cases of ventricular septal defect he has operated on in his total series of 275 patients on whom he has used a bubble type of oxygenator. Of these

236

113 patients twenty-one died giving an overall mortality of 18 per cent. ; under two years of age thirteen out of thirty-seven patients died (a mortality of 35 per cent.) of seventy-six patients over two years of age only eight died (a mortality of 10 per cent.).

CONCLUSION

I am conscious that I have omitted much that I should have discussed. The very vastness of the field alone testifies to the spectacular and rapid development of cardiac surgery. Of the conditions I have omitted I would especially mention that of the surgery of myocardial ischaemia or coronary insufficiency. Here we have a killing disease of great general importance. Surgery can do something for it but we hope that the future will see even greater developments.

I have also had to omit all discussion of cardiac resuscitation, a subject dealt with very ably by my colleague Mr. B. B. Milstein in a Hunterian Lecture in 1956.

I will conclude by quoting yet again some words from Ballance's Bradshaw Lecture of 1919 ; I will remind you that he said " The reward of success will attend our efforts in so far as the heart is treated as one of the ordinary tissues of the body and the method of operation conforms to the fundamental principles of surgery."

In this lecture I have tried to speak as little as possible about detail and as much as possible about principles for I am sure that Ballance was right when he said that true progress in the surgery of the heart must be determined by adherence to the fundamental principles that govern the surgery of all other parts of the body.

REFERENCES

BALLANCE, C. A. (1920) *The Bradshaw Lecture on the surgery of the heart.* London.
————— (1924) *Lancet* **1**, 1, 73, 134.
BEDFORD D. E., SELLORS, T. H., *et al.* (1957) *Lancet,* **1**, 1255.
BLALOCK, A., and TAUSSIG, H. B. (1945) *J. Amer. med. Ass.* **128**, 189.
BROCK, R. C. (1957a) *Brit. med. J.* **1**, 1019.
————— (1957b) *Guy's Hosp. Rep.* **106**, 221.
————— and FLEMING, P. R. (1956) *Guy's Hosp. Rep.* **105**, 391.
————— and ROSS, D. N. (1955) *Guy's Hosp. Rep.* **104**, 99.
HARKEN, D. E. (1946) *Surg. Gynec. Obstet.* **83**, 117.
KIRKLIN, J. W., ELLIS, F. H., and BARRATT-BOYES, B. G. (1956) *Surg. Gynec. Obstet.* **103**, 646.
MILSTEIN, B. B. (1956) *Ann. Roy. Coll. Surg. Engl.* **19**, 69.
PARÉ, A. (1691) *The works of Ambrose Paré,* p. 95.
REHN, L. (1897) *Arch. klin. Chir.* **55**, 315.
ROSS, D. N. (1954a) *Guy's Hosp. Rep.* **103**, 97.
————— (1954b) *Lancet* **1**, 1108.
SOUTTAR, H. S. (1925) *Brit. med. J.* **2**, 603.

ANATOMICAL MUSEUM

THE SPECIAL DISPLAYS have been temporarily discontinued owing to reorganization of the museum.

THE THERAPEUTIC USE OF RADIOACTIVE ISOTOPES

Lecture delivered at the Royal College of Surgeons of England

on
9th May 1958

by

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INTRODUCTION

RADIOACTIVE ISOTOPES FIRST became available for use in medicine in this country at the end of 1948. Their experimental use in the field of investigation has developed rapidly, though medicine has perhaps been slow to adopt these methods for the routine study of function in the living person in any but a few special hospitals and with the exception of the study of thyroid disorders.

The therapeutic use of radioactive isotopes was started in this country at the Royal Marsden Hospital in 1948. The main lines of what is being done to-day were established within the first year (Smithers, 1951), and until quite recently there seemed to be a distinct slowing down in initiative after the first rush of interest and enthusiasm. Existing radio-therapeutic methods were improved by the introduction of artificial radioisotopes, but only in the field of differential absorption was a quite new therapeutic development made possible.

TABLE I

RADIOACTIVE ISOTOPES MENTIONED IN THE TEXT

Isotope	Half-life	Maximum β-Energy (MeV)	Mean γ-Energy (MeV)
I^{131}	8 days	0·8	0·4
Na^{24}	15 hours	1·4	2·07
Br^{82}	36 hours	0·47	0·8
P^{32}	14·3 days	1·7	None
Au^{198}	2·7 days	0·96	0·41
Ag^{111}	7·6 days	1·0	0·3
Y^{90}	2·7 days	2·2	None
Cs^{137}	30 years	0·52	0·66
Co^{60}	5·3 years	0·31	1·25
Ta^{182}	111 days	0·5	1·1
Ir^{192}	75 days	0·67	0·60
Sr^{90}	28 years	0·61	None
Ce^{144}	280 days	0·30	0·1

The present therapeutic uses of artificial radioactive isotopes may be divided into six groups:

1. Differential absorption, using either inorganic or organic materials.
2. Surface application using either solid or fluid sources.

3. Instillation into the body for either direct local effect or for effect when transported elsewhere.

4. Infiltration, which is the equivalent of interstitial implantation using fluid sources.

5. Implantation, which may be either temporary or permanent.

6. Teletherapy using large sources, either at a short or long source-skin distance.

1. Differential absorption

The outstanding use of inorganic materials for therapeutic irradiation by differential absorption has been radioactive iodine (I^{131}). This material has been used primarily for the treatment of thyrotoxicosis and thyroid carcinoma. Except for some minor uptake in the salivary glands, iodine localizes well in the thyroid to the comparative exclusion of other tissues and can be used for depressing thyroid function by destruction of the gland itself. Its use in thyrotoxicosis and thyroid carcinoma has been the subject of another lecture in this series and will not be dealt with further here.

When the radioactive uptake by the thyroid has been blocked by previous administration of inactive iodine, I^{131} may then be given for general distribution through the circulation and has been used in a few cases for the treatment of disseminated radiosensitive carcinomas and for multiple myelomatosis but without any great success. I^{131} labelled human serum albumin has been used in the same way (Kriss, Bierman, Thomas and Newell, 1955 ; Kay, Ledlie and Sbresni, 1958), and so has radioactive sodium (Na^{24}).

The other inorganic substance widely used for differential absorption is radioactive phosphorus (P^{32}). The demand of growing cells for phosphorus leads to some slight differential uptake in tumours which are growing rapidly. This has been frequently demonstrated and can be used at times as a diagnostic test, for example in the brain (Selverstone, Solomon and Sweet, 1949), eye (Palin and Tudway, 1955 ; Terner, Leopold and Eisenberg, 1956), or cervix uteri (Papaloucas, 1958). The difference in uptake between the most rapidly growing tumours and some normal tissues, however, is seldom sufficient to make this method of much therapeutic value. The damage done to the bone marrow, for example, by P^{32} usually outweighs its value for generalized disseminated radio-sensitive tumours, though a few dramatic results have been reported (Smithers, 1951).

The chief use of P^{32} in therapeutics has been in the treatment of poly-cythaemia vera (Erf and Lawrence, 1941 ; Harman, Hart and Ledlie, 1955), haemorrhagic thrombocythaemia (Fountain, 1958 ; Alphos, Field and Ledlie, 1958), lymphatic leukaemia (Osgood, 1951), lymphosarcoma, reticulum-cell sarcoma, and some early cases of Hodgkin's disease (Low-Beer, 1954).

239

Interest at present lies chiefly in finding methods of increasing he differential absorption of radioactive materials in selected tissues, mo tly through the use of hormones. The best example is the use of thyrɔid stimulating hormone from the pituitary to persuade thyroid tumours to take up more iodine. Another interesting example is the use of testosterone in an attempt to promote localization of P^{32} in metastases in bone (Maxfield, Maxfield and Maxfield, 1958).

It is to be hoped that further development in this direction will take place, since the effect of radioactive isotopes on the control of disseminated tumours, when good localization can be obtained, may be dramatic and occurs at a time when other effective treatments for these patients are seldom available. Little work has yet been done, for instance, on the tumour localization of labelled organic materials and more is needed on the localization of inert particles by the reticuloendothelial system, using radioactive colloids (Hahn, Carothers, Hilliard, Bernard and Jackson, 1956).

2. Surface application

The surface application of radioactive isotopes may be carried out with either fluid or solid sources, used either for their beta- or gamma-ray emissions.

Solid radioactive isotopes employed as gamma-ray sources for surface applications are usually radioactive cobalt (Co^{60}), radioactive tantalum (Ta^{182}), and radioactive iridium (Ir^{192}). Co^{60} has been used in a number of forms, usually as rods or needles applied on a mould, but has also been incorporated as a powder in a malleable material which is moulded directly on to the surface (Becker and Scheer, 1951). Ta^{182} has been used mostly as wire which is wound on to a prepared mould (Fig. 1). Ir^{192}, with its softer gamma-ray emission, has not been much in the field for surface application but, as a large source held at a short distance from the skin, it gives an energy absorption distribution in the tissues very similar to a radium applicator and is useful as an alternative to such radium techniques (Mitchell and Haybittle, 1958).

Solid sources used for beta-ray applicators have mostly contained radioactive strontium (Sr^{90})—usually in the form of foil—and have been chiefly employed in ophthalmology (Lederman and Sinclair, 1956). P^{32} has been incorporated in a plastic sheet from which many applicators of varied shape may be cut and applied for the treatment of the most superficial lesions (Sinclair and Blondal, 1952). A rather elegant beta-ray applicator has also been made using radioactive cerium (Ce^{144}) (Haybittle, 1953).

Fluids for surface application have been used predominantly in the bladder. The fluid may be inserted in a bag which distends the bladder, irradiating the whole of the mucosal surface from within (Fig. 2) (Wallace, Walton and Sinclair, 1949). Isotopes made use of in this way have been Na^{24}, radioactive bromine (Br^{82}), and Co^{60} (Müller, 1949). Fluid sus-

pensions of inert radioactivated particles have also been employed for surface application without the necessity of using a bag, by instilling the non-absorbable fluid directly into the cavity concerned. Again the bladder has been the site where this method has been most often applied and both radioactive gold (Au^{198}) and radioactive yttrium (Y^{90}) colloids
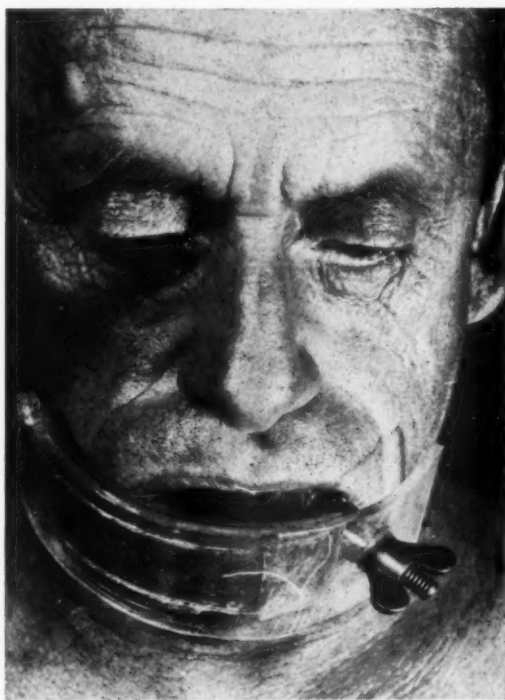
Fig. 1. Radioactive tantalum wire applied on a mould.

have been employed (Ellis and Oliver, 1955 ; Mackay, Smithers and Wallace, 1958). These methods are sometimes applicable to other body cavities and to artificially created cavities following the removal of tumours where it is thought advisable to irradiate the tumour bed owing to the risk of neoplastic cells remaining.

Pleural and peritoneal effusions due to neoplastic infiltration have been treated with Au^{198} colloid (Müller, 1950 ; Walton and Sinclair, 1952 ; Mackay, 1957). With rapidly recurring effusions necessitating repeated aspirations, this treatment may at times be most effective as a palliative measure.

241
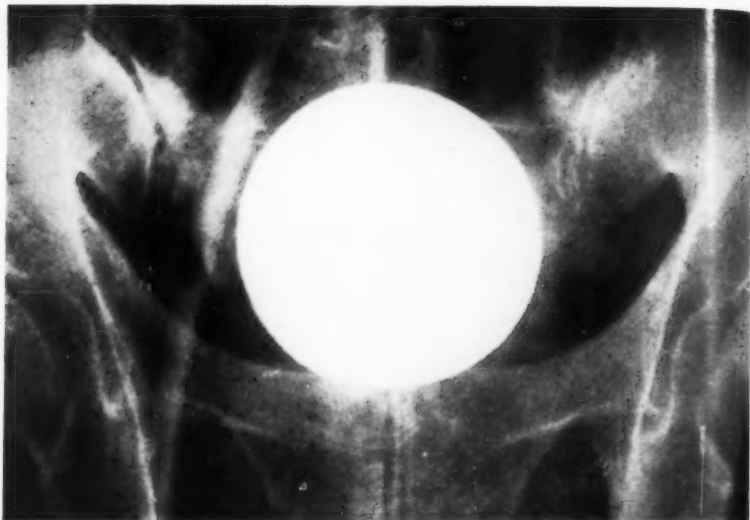
Fig. 2.   Bag in the bladder for the application of radioactive fluids.

3. Instillation

Instillation into the body for absorption rather than surface application has been attempted experimentally, chiefly in the hope of concentration of the material in the regional lymph nodes.   Colloidal Au^{198} and radio-active colloidal silver (Ag^{111}) have been tried, and silver-coated Au^{198} particles and carbon particles plated with Au^{198} (Hahn, 1956).   The favourite site for this work has been the lung and some interesting experimental work has been done in dogs (Bryant, Berg and Christophersen 1953 ; Wheeler, Jaques, Allen, Soltes, O'Conor and Black, 1956).   An extension of this work has been the direct injection of radioactive material into the pulmonary artery by cardiac catheterization (Müller and Rossier, 1951 ; Pochin, Cook, Cunningham, Hollman, Hudswell and Payne, 1954). While there is no doubt that good localization can sometimes be obtained in this way and that interesting differences have been found between the rates and degrees of absorption in lymph nodes of materials with different particle sizes and of different chemical composition, the method so far has been of little practical value.

4. Infiltration

Direct tumour infiltration with radioactive materials is the equivalent of an implant using a fluid medium.   A number of materials have been used for this purpose, P^{32}, colloidal Au^{198}, chromic radiophosphate and others.   Such infiltration has been done in the prostate (Flocks, Kerr, Elkins and Culp, 1952 ; Bulkeley, Cooper and O'Conor, 1956), in the parametrium (Kottmeier, 1954), and in various tumours, particularly

242

those forming fixed masses in the neck which are inoperable and have persisted after previous external irradiation.

The raising of tissue tension by the injection under pressure of fluids into tumours would seem likely to increase the risk of spread, and this method has not been regarded with much favour despite some isolated reports of a dramatic response. It can be a useful method of palliative treatment in a few instances where dissemination has already taken place and the local tumour presents a difficult problem for external irradiation or implant.

5. Implantation

Radioactive isotopes of short half-life may be employed for permanent implants and of longer half-life for temporary implants in much the same way as radium has been used for so long. The chief materials employed

Fig. 3. Radioactive gold grains implanted into a carcinoma of the pancreas.

243

as radium substitutes in implant work have been Co^{60} (Meschan, Edwards and Rosenbaum, 1951) either in tubes or needles or as small grains contained in plastic tubing (Morton, Callendine and Myers, 1951), and Ta^{182} in the form of wire (Wallace, Stapleton and Turner, 1952), removable when treatment is completed. The most successful of these methods so far has been the Ta^{182} wire implantation of bladder tumours (Mackay, Smithers and Wallace, 1958). Ir^{192} has also been used in small grains contained in nylon tubing for temporary implants, but this material is also useful for permanent implants and has been employed with advantage in this way by Henschke (1957). Multiple small sources of this kind have been extensively used as a substitute for radon seeds, and Au^{198} grains

Fig. 4. Radioactive yttrium rods implanted in the pituitary.

244

particularly have been implanted (Hodt, Sinclair and Smithers, 1952) into a wide variety of tumours throughout the body (Fig. 3). These are permanent implants made with an isotope of short half-life. Pure beta-ray emitters may be useful for permanent implants and Y^{90} has been used for pituitary destruction (Fig. 4) in the treatment of some hormone-dependent tumours mostly of the breast (Forrest, 1957 ; Greening, 1957).

Some artificial radioactive isotopes have a notable advantage in implant work : they may be kept always ready for use in the operating theatre. An implant can then be done at the time of exploration if a tumour is found to be irremovable, and a major operation not leading to an attempt at any effective treatment avoided. The two sites at which such implants have been most frequently done have been the stomach (Fleming and Barrett, 1955), and the lung (James, Henschke and Myers, 1953 ; Cleland, 1958).

These new methods of radioactive implantation differ in no essentials from the old, but they have added variety and given a new flexibility to these procedures.

6. Teletherapy

Large sources of radioactive materials are useful for beam therapy and have been employed as such for many years in the form of teleradium units, from the days of the 1 gramme " bomb " to the present-day 10-12 gramme teleradium units. Apart from Ir^{192} already mentioned, the other radioactive materials so far inserted into teletherapy units have been radioactive caesium (Cs^{137}) and Co^{60}.

Cs^{137} is a fission product obtained by separation from waste in atomic energy plants. It is used in treatment units as a substitute for 250kV X-radiation, providing a beam of better quality with less differential bone absorption while being comparatively cheap to install and trouble-free to run. It has a convenient half-life of thirty years. Smaller units for treatment of more superficial head and neck tumours are also being designed using Cs^{137}. These are a possible replacement for the tele-radium units at present in use.

Teletherapy with radioactive isotopes has been chiefly developed with Co^{60} sources in 1,500-2,000 curie units as a substitute for supervoltage X-ray machines. These emit gamma-rays of 1·17 and 1·33 MeV but are approximately equivalent to 3 MeV X-rays in quality because of the softer components contained in X-ray beams which are designated by their peak voltage. The improved depth-dose and quality of Co^{60} tele-therapy units are raising the standard of palliative X-ray therapy for deep-seated malignant disease. Their output of radiation and the sharp-ness of the edges of their beams are not, however, as satisfactory as those of the corresponding supervoltage X-ray plants in the 2-4 million volt range. While this may be of little consequence in large-field palliative treatment, it can be a real disadvantage in the accurate localization of high dose treatment with economy of total energy absorption in attempts at

curative therapy. Another disadvantage is the comparatively short half-life
of Co⁶⁰, requiring replacement of the source every few years and con-
tinuous attention to the changing dose-rate. Nevertheless, these are most
valuable smooth-running units, requiring no staff of technicians for t eir
maintenance and comparatively cheap to run. They seem destined to be
the major source of beam therapy for the routine treatment of tumours
some depth below the surface in all but the largest radiotherapy depart-
ments for some years to come.

REFERENCES

ALPHOS, L. G., FIELD, E. O., and LEDLIE. E. M. (1958) *Clinical Trials with DFP* ³²—
   in preparation.
BECKER, J., and SCHEER, K. E. (1951) *Strahlentherapie* **85**, 581.
BRYANT, J. R., BERG, H. F., and CHRISTOPHERSEN, W. M. (1953) *J. thorac. Surg.* **26**, 221.
BULKELEY, G. J., COOPER, J. A. D., and O'CONOR, V. J. (1956) *J. Urol.* **75**, 837.
CLELAND, W. P. (1958) *Carcinoma of the lung*, edited by J. R. Bignall. p. 223. Edinburgh
   and London, E. & S. Livingstone Ltd.
ELLIS, F., and OLIVER, R. (1955) *Brit. med. J.* **1**, 136.
ERF, L. A., and LAWRENCE, J. H. (1941) *Ann. intern. Med.* **15**, 276.
FLEMING, J. A. C., and BARRETT, N. R. (1955) *British practice in radiotherapy*, edited
   by E. R. Carling, B. W. Windeyer and D. W. Smithers. p. 306. London, Butter-
   worth.
FLOCKS, R. H., KERR, H. D., ELKINS, H. B., and CULP, D. A. (1952) *J. Urol.* **68**, 510.
FORREST, A. P. M. (1957) In discussion on " Hypophysectomy for cancer " *Proc. roy.
   Soc. Med.* **50**, 864.
FOUNTAIN, J. R. (1958) *Brit. med. J.* **2**, 126.
GREENING, W. P. (1957) In discussion on " Hypophysectomy for cancer " *Proc. roy.
   Soc. Med.* **50**, 867.
HAHN, P. F. (1956) *Therapeutic use of artificial radioisotopes*, edited by P. F. Hahn.
   p. 365. New York, John Wiley & Sons, Inc. London, Chapman & Hall, Limited.
   —— CAROTHERS, E. L., HILLIARD, G. W., BERNARD, L., and JACKSON, M. (1956)
   Therapeutic use of artificial radioisotopes, edited by P. F. Hahn. p. 128. New
   York, John Wiley & Sons, Inc. London, Chapman & Hall, Limited.
HARMAN, J. B., HART, P. L. DE V., and LEDLIE, E. M. (1955) *Brit. med. J.* **1**, 930.
HAYBITTLE, J. L. (1953) *Brit. J. Radiol.* **26**, 423.
HENSCHKE, U. K. (1957) *Interstitial implantation in the treatment of primary broncho-
   genic carcinoma*. Paper read at the Symposium on Lung Cancer, American Radium
   Society Meeting, 1957.
HODT, H. J., SINCLAIR, W. K., and SMITHERS, D. W. (1952) *Brit. J. Radiol.* **25**, 419.
JAMES, A. G., HENSCHKE, U. K., and MYERS, W. G. (1953) *Cancer* **6**, 1034.
KAY, H. E. M., LEDLIE, E. M., and SBRESNI, R. C. (1958) *Treatment of multiple myeloma-
   tosis with particular reference to radioactive iodine*—in preparation.
KOTTMEIER, H. L. (1954) *Gynaecologia* **138**, 287.
KRISS, J. P., BIERMAN, H. R., THOMAS, S. F., and NEWELL, R. R. (1955) *Radiology* **65**,
   241.
LEDERMAN, M., and SINCLAIR, W. K. (1956) *Therapeutic use of artificial radioisotopes*,
   edited by P. F. Hahn. p. 344. New York, John Wiley & Sons, Inc. London,
   Chapman & Hall, Limited.
LOW-BEER, B. V. A. (1954) *Acta radiol. Suppl.* **116**, p. 309.
MACKAY, N. R. (1957) *Lancet* **2**, 761.
MACKAY, N. R., SMITHERS, D. W., and WALLACE, D. M. (1958) *Tumours of the bladder*,
   edited by D. M. Wallace. p. 262. Edinburgh and London, E. & S. Livingstone Ltd.
MAXFIELD, J. R., MAXFIELD, J. G. S., and MAXFIELD, W. S. (1958) *Sth. med. J.* **51**, 320.
MESCHAN, I., EDWARDS, R. R., and ROSENBAUM, P. J. (1951) *Amer. J. Roentgenol.* **65**, 255.
MITCHELL, J. S., and HAYBITTLE, J. L. (1958) *Acta radiol.* **49**, 233.
MORTON, J. L., CALLENDINE, G. W., and MYERS, W. G. (1951) *Radiology* **56**, 553.
MULLER, J. H. (1949) *Schweiz. med. Wschr.* **79**, 547.
—— (1950) *Gynaecoligia* **129**, 289.
—— and ROSSIER, P. H. (1951) *Acta radiol.* **35**, 449.

OSGOOD, E. E. (1951) *Arch. intern. Med.* **87**, 329.
PALIN, A., and TUDWAY, R. C. (1955) *Trans. Ophthal. Soc. U.K.* **75**, 281.
PAPALOUCAS, A. C. (1958) *Selective Uptake of ^{32}P by the Cervix in Patients with Carcinoma before and after treatment and in normal subjects.*—To be published in *Brit. J. Cancer.*
POCHIN, E. E., COOK, G. B., CUNNINGHAM, R. M., HOLLMAN, A., HUDSWELL, T., and PAYNE, B. R. (1954) *Radioisotope Conference 1954*, Vol. 1, p. 31. Medical and Physiological Applications. London, Butterworth.
SELVERSTONE, B., SOLOMON, A. K., and SWEET, W. H. (1949) *J. Amer. med. Ass.* **140**, 277.
SINCLAIR, W. K., and BLONDAL, H. (1952) *Brit. J. Radiol.* **25**, 360.
SMITHERS, D. W. (1951) *Acta radiol.* **35**, 49.
TERNER, I. S., LEOPOLD, I. H., and EISENBERG, I. J. (1956) *Arch. Ophthal.* **55**, 52.
WALLACE, D. M., STAPLETON, J. E., and TURNER, R. C. (1952) *Brit. J. Radiol.* **25**, 421.
————— WALTON, R. J., and SINCLAIR, W. K. (1949) *Brit. J. Urol.* **21**, 357.
WALTON, R. J., and SINCLAIR, W. K. (1952) *Brit. med. Bull.* **8**, 165.
WHEELER, H. B., JAQUES, W. E., ALLEN, M. B., SOLTES M., O'CONOR, V. J., and BLACK, H. (1956) *Surg. Gynec. Obstet.* **102**, 166.

DONATIONS

DURING THE LAST month the following generous donations have been received :

Appeal Fund.

 £500   The Executors of the late Sir Thomas Dunhill.

Department of Dental Science.

 £50   Morgan Grenfell & Co. Ltd. (further donation).
 £50   Baring Brothers & Co. Ltd. (further donation).

HAND SURGERY

THE HAND CLUB of Great Britain and the Second Hand Club are holding an open meeting at the Royal College of Surgeons on Saturday, November 22, from 10 a.m. to 4 p.m. with lunch at the College.

Any surgeon interested in Hand Surgery is invited to attend. Further particulars may be obtained from the Hon. Secretary, The Second Hand Club, H. Graham Stack, 150, Harley Street, W.1.

MONTHLY DINNERS

MONTHLY DINNERS ARE held in the College on the Wednesday before the second Thursday of each month. The following are entitled to attend with their guests : all diplomates and students of the College and members of the Associations linked to the College through the Joint Secretariat. It is not necessarily intended that guests should be members of the medical profession.

The next four dinners will be held at 7 for 7.30 on 8th October, 12th November, 10th December and 7th January.

The cost is £1 10s. 0d., which includes cocktails before dinner and wine at the table. Applications for tickets, accompanied by a cheque for the appropriate amount, must be sent to the Deputy Secretary at least a week before the date of the dinner. Cheques should be made payable to " Royal College of Surgeons of England." The dress is lounge suit.

CYTOLOGICAL DIAGNOSIS OF PROSTATIC CARCINOMA

by

J. Bamforth, M.D., F.R.C.P., F.R.C.O.G.
Clinicopathological Laboratories, Imperial Cancer Research Fund

CYTOLOGICAL EXAMINATION AS an aid to diagnosis in carcinoma of the prostate has not been practised to the same extent as in other regions of the body, and comparatively few publications have appeared on this subject. Mulholland (1931), at a Staff Meeting of the Mayo Clinic, reported his results of the cytological examination of smears of prostatic secretion obtained from innocent and from malignant prostates and in twenty-three of thirty cases of prostatic carcinoma demonstrated clumps of cells of atypical character. He did not actually claim these to be malignant though very probably they were. In the discussion which followed, McCarty, showing some of his own preparations, said that exfoliation of malignant cells was a likely occurrence in this condition. Herbut and Lubin (1947) and Peters (1950) were amongst the first to show the possibilities of cytology in the diagnosis of carcinoma of the prostate.

There is little doubt that in the diagnosis of carcinoma, cytological examination of prostatic secretion following massage of the prostate yields much better results than that of urinary deposit. This is clearly shown in the publications of Foot and his colleagues (1958) and of Fergusson and Gibson (1956). The former examining specimens of which 90 per cent. were urinary sediments, found only 15 per cent. positive results and there were 64 per cent. false negative reports. The latter, examining prostatic secretion, reported an accuracy of 94·7 per cent. in a series of forty cases.

In my own experience, of 513 specimens of prostatic secretion received from different sources, 177 (about one-third) have proved to be inadequate. These smear preparations did not contain sufficient prostatic epithelial cells for critical examination ; in many cases there were none. It is true that in some cases of scirrhous carcinoma malignant cells cannot be found in the smear after massage but this applies only to a small minority of cases of prostatic cancer. Fergusson and Gibson described in detail the technique of prostatic massage required to procure an adequate quantity of secretion containing prostatic epithelial cells from every part of the organ. It is believed by some that pressure on the prostate may help to spread malignant disease, if present. It would appear, however, that this danger may be exaggerated. In latent carcinoma—a condition occurring in a significant percentage of old prostates, discovered at autopsy, and devoid of clinical activity during life—it has been shown by Franks (1954) and by others that invasion of the capsule and spread into the

248

lymphatics has already taken place. Moreover, in many patients with active clinical symptoms attending for medical examination for the first time, metastases are already present and malignant cells can be demonstrated in the bone marrow before X-ray diagnosis of marrow involvement is possible. Although the quality of the prostatic smears obtained varies to some extent in different hands, it would appear that in many cases there is difficulty in obtaining a satisfactory specimen. On a few occasions smears containing secretion of the seminal vesicle have been received. These usually contain large numbers of spermatozoa, many of which have been ingested by large phagocytic cells which are easily recognizable. In addition, many epithelial cells from the vesicle are often present, both singly and in clumps ; these cells tend to be triangular in shape, often contain a little yellowish pigment, and may easily be mistaken for malignant prostatic cells, especially if spermatozoa are absent. Although in most instances " seminal vesicle " smears are useless, in some cases clumps of malignant prostatic cells may be found in them.

Technique

The smears are made on glass slides from the secretion which comes from the pipe after massage of the prostate ; they should be about as thick as a blood film and whilst wet are placed in Schaudinn's fluid for fixation. The optimum time for fixation is fifteen to twenty minutes but slides may be left in the fluid overnight. They are then transferred to methylated spirits to which a few drops of T. iodi have been added to remove any crystals of mercuric chloride remaining from the Schaudinn's fluid. The slides are stained with Mayer's haemalum and eosin and mounted in Canada balsam. This is the method originally used by Dudgeon and his colleagues (1927-1934) in the histological examination of tumours, and for full details their papers should be consulted. The prostatic smears can be conveniently taken to the laboratory in the fixative contained in Coplin jars made of polythene (Young, 1953) and usually two, or sometimes three, smears are received from each patient.

Innocent and malignant prostatic epithelial cells

Almost all the smears of prostatic secretion I have received for cytological examination have been obtained from old men. Very few were under sixty years of age, and the majority were above sixty-five. In many cases the prostate gland was enlarged owing to the presence of benign hypertrophy (or, as it used to be called, "Adenoma "). The epithelial cells exfoliated from prostates of this age can be studied by making stained preparations from the cut surface of the organ (immediately after its removal by operation) in the *fresh unfixed* condition. The surface is scraped with a sharp scalpel. From the juice which exudes on to the scalpel, films are made and fixed immediately, whilst still wet, in Schaudinn's solution and stained and mounted as already described. In

249

innocent prostates an appreciable number of epithelial cells can be detached by massage, appearing singly or in aggregates of varying size in smear preparations. Sheets of innocent cells, evenly distributed and equidistant from one another, are seen, often discretely separated by definite cell membranes like tiling on a floor. The cells show a considerable uniformity in shape and size in any particular sheet (Fig. 1)
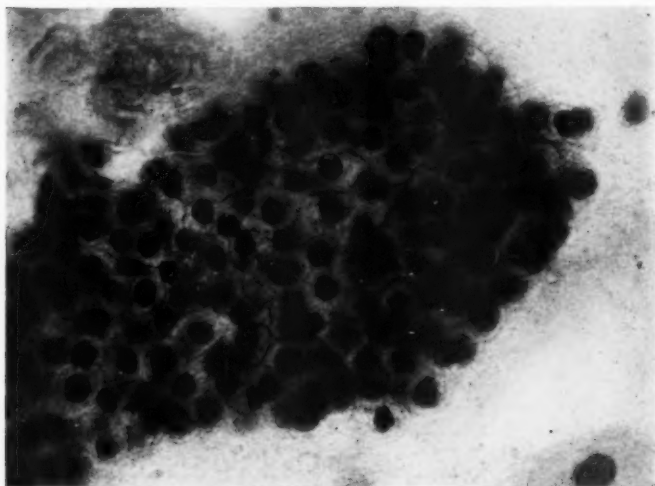
Fig. 1. Part of a sheet of innocent prostatic epithelium. There is considerable uniformity in size, shape and arrangement of the cells which are separated by cell membranes and show occasional nucleoli. × 550.

but not in different sheets. In cases of benign hypertrophy small collections of typical columnar cells may be found and these cellular appearances can be seen in smears obtained by massage from innocent prostates.

In most cases of carcinoma of the prostate quite large numbers of malignant cells are exfoliated and occur singly and in clumps of varying size. In some cases large collections of malignant cells are found. For the purposes of diagnosis single cells are unreliable and only clumps are considered. The latter frequently take the form of casts, resembling those from the renal tubules as seen in the urine in nephritis. In typical malignant cases the cells are crowded together, the nuclei overlap, and cell boundaries cannot be determined (Fig. 2)—an appearance easily distinguished from that seen in non-malignant disease. In some cases, however, crowding may not be so marked but can be seen, especially at the edges of the cast. Sheets of cells, both innocent and malignant, may be found in the same smear (Figs. 1 and 2). In addition to the

250

crowding of cells other well-recognized criteria of malignant cells in general may be found in cases of carcinoma of the prostate. For example, the relatively large size of the nucleus, its hyperchromatism, and the unduly
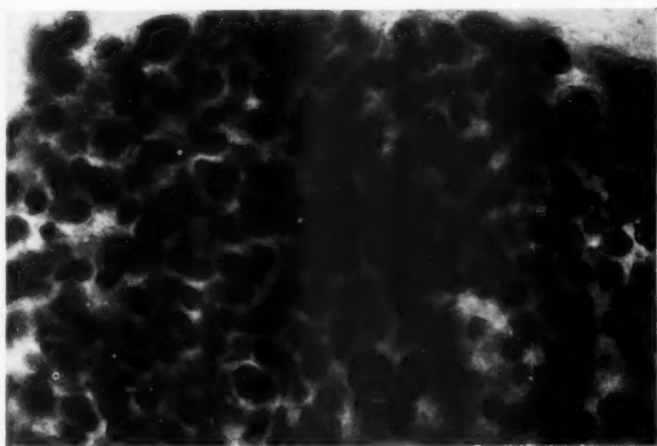
Fig. 2.   A field in the same smear showing a typical crowded cast of malignant cells found after massage. × 550.

large nucleolus or nucleoli are very prominent in some cases.   The chromatin is not so smooth and uniform as in normal cells but tends to be coarse and occur in small clumps. There may be more variation in the size and shape of the cells. It is unusual to find more than one or two of these criteria in any given smear. The crowded cast is found in the majority of cases and facilitates the diagnosis. Where crowding is slight or absent, and especially when the cell aggregates are small, the recognition of one or more of the above criteria may help considerably. It is important to identify the different types of malignant cells found in the smear after massage with those seen in histological sections when such are available from biopsy, from prostatectomy or autopsy. In this way only is it possible for standards to be set up and knowledge extended.

Different cell types of prostatic carcinoma

Different cytological pictures may be observed in the collections of malignant cells found in prostatic smears after massage of different patients. All the cases now described have been confirmed histologically either as the result of biopsy or of postmortem examination. In the majority the crowded clumps of cells, often in the form of " renal casts," have been found. The cells, usually round or oval in shape, show considerable differences in size in different cases ; the average diameter is

251
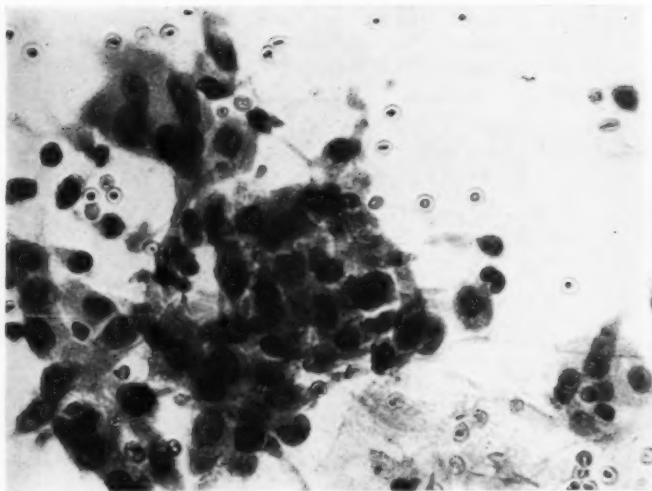
Fig. 3. A group of malignant prostatic cells of transitional type arising from the ducts on the surface of the prostate : found in smear after massage. × 550.
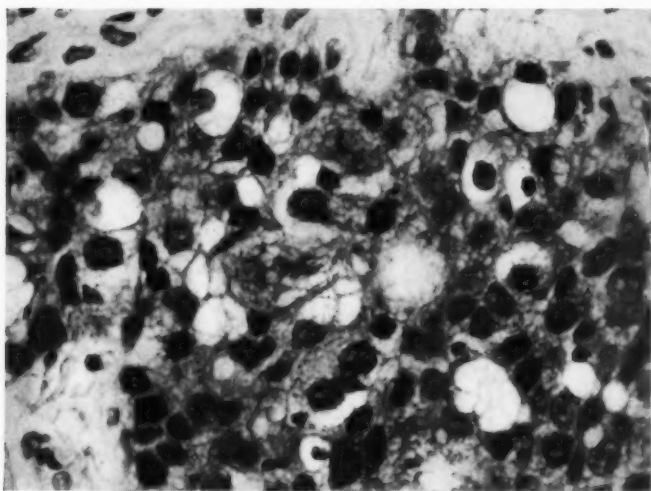
Fig. 4. Histological section of carcinoma of the prostate. The appearances confirm the presence of malignant cells as seen in Figure 3. × 550.

252
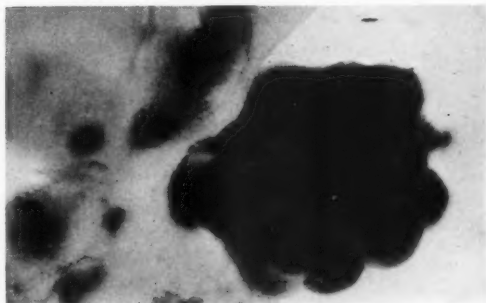
Fig. 5.   A small clump of malignant cells with prominent nucleoli found in smear after prostatic massage.   × 550.
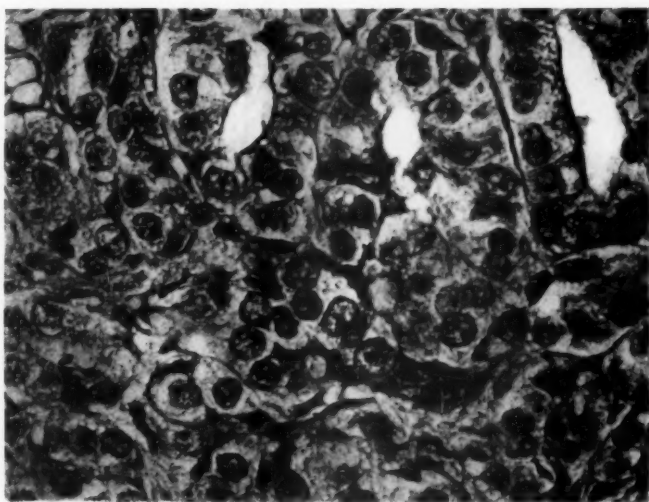
Fig. 6.   Section of adenocarcinoma of prostate confirming the presence of the malignant cells shown in the preceding figure.   The nucleoli are seen in the acinar cells.   × 550.

about 11µ.   The larger cells have a relatively larger amount of cytoplasm than the smaller but the nuclear cytoplasmic ratio is greater than normal. In small clumps of crowded cells little if any cytoplasm is discernible. There is often a definite variation in shape and size amongst the cells in the individual clump.   In some cases enlarged nucleoli and coarseness of the nuclear chromatin are found but as a rule these changes are not

253
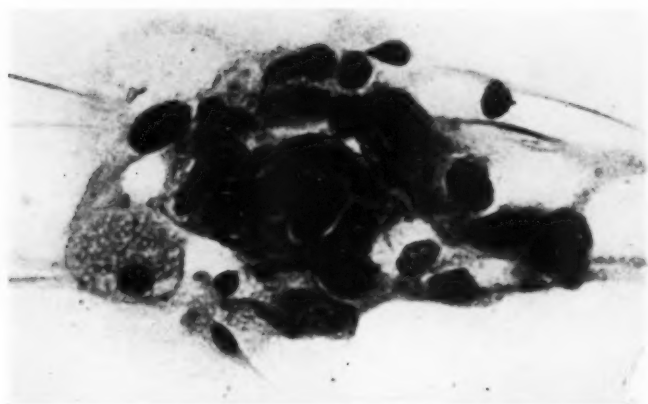
Fig. 7. A clump of malignant cells with extremely large nucleoli seen in a prostati smear after massage. × 550.
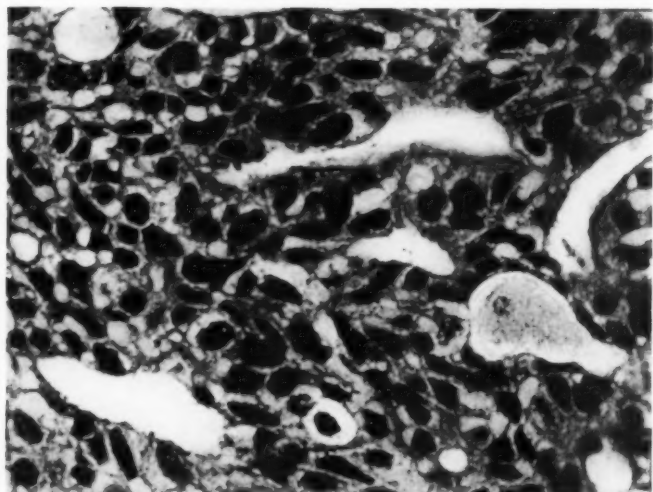
Fig. 8. Histological confirmation of the presence of malignant cells shown in Figure 7. The very large nucleoli are not seen. × 550.

254
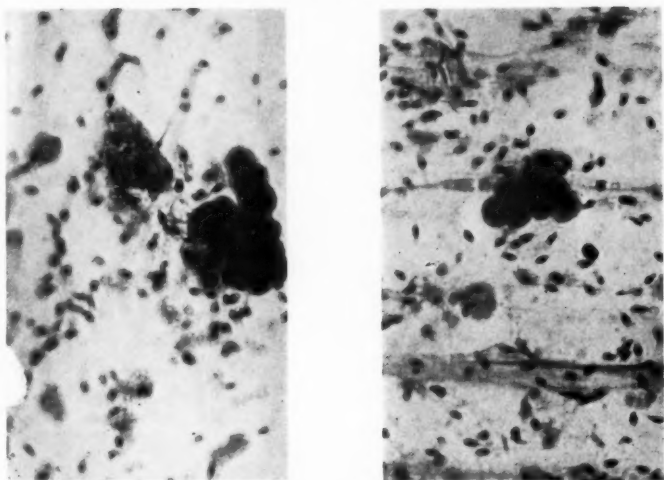
Fig. 9. Groups of small hyperchromatic malignant spheroidal cells seen in prostatic smear after massage. × 550.
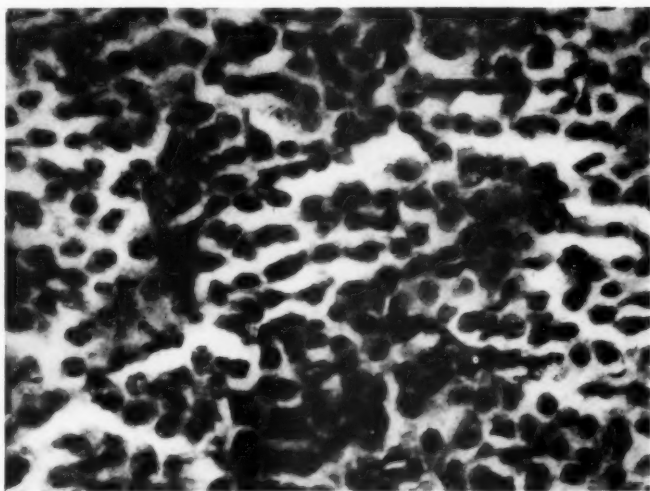
Fig. 10. Section of secondary deposit in the marrow of the ilium showing small spheroidal cell carcinoma—confirming the cells seen in Figure 9. × 550.

255
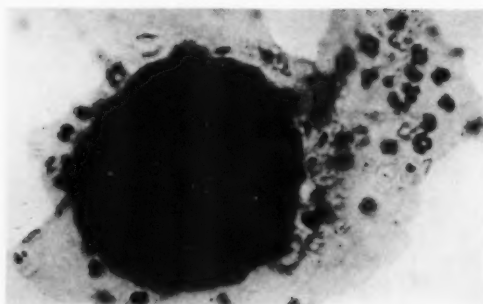
Fig. 11.   A cup-shaped group of malignant cells seen in smear following prostatic massage.   × 550.
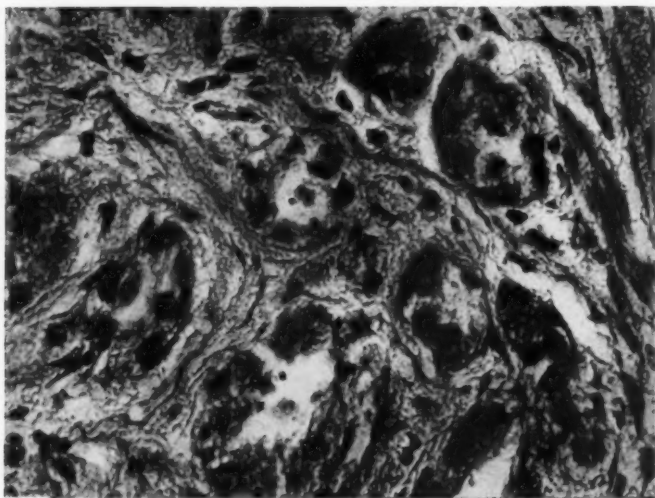
Fig. 12.   Histological section of prostatic carcinoma, confirming the presence of malignant cells seen in the preceding figure.   × 550.

prominent.   The typical crowded arrangement of the cells which are definitely hyperchromatic is usually quite sufficient to denote malignancy. In a very few instances the clumps are formed by cells in which both cytoplasm and nucleus stain less intensely.   The cells are larger than the average and show resemblance to the transitional cells of the bladder;

their arrangement is irregular but they are not so crowded (Fig. 3). Confirmation of this cell type of prostatic carcinoma was obtained by section (Fig. 4). It has been found that in these cases the neoplasm arises in the ducts of the prostate and as it enlarges it projects into the floor of the bladder. It is clear that in this type of carcinoma difficulty may arise as to whether the prostate or the bladder is the primary seat of growth. In one case two different types of cells were found in the smear, one showing the large transitional-like appearance just described, the other consisting of smaller cells closely packed together. Subsequent histological examination of the prostate showed a carcinoma formed of large cells on the surface blending with the smaller, more deeply stained cells below.

In a few cases I have found that enlarged nucleoli constitute a striking feature of malignant cells. More than one nucleolus may be present. Where the cell clumps are small and the crowding of the cells is slight the relatively large nuclei and the prominent nucleoli provide strong evidence of malignancy (Figs. 5 and 6). The prominent nucleoli are not always so well shown in the paraffin sections as in the prostatic smear (Figs. 7 and 8).

Occasionally the malignant cells are found in small groups and consist of small round hyperchromatic cells standing out prominently in the smear. These cells, in which little or no crowding is present, possess a certain amount of cytoplasm surrounding the nucleus and resemble lymphocytes (Figs. 9 and 10).

There are cases also in which some of the malignant cells are arranged in syncytial masses of cytoplasm containing a few nuclei which vary in size and shape and are arranged irregularly.

Finally, there are groups of malignant cells formed in the shape of a cup. These have been found in smears from two patients. The cells at the periphery of the cup are in focus and clearly seen whilst those in the centre are invisible, and *vice versa* (Figs. 11 and 12). This is not an appearance peculiar to prostatic carcinoma for similar aggregates of malignant cells have been found in the pleural and peritoneal fluids in cases of primary carcinoma of the breast and ovary.

The effect of oestrogen treatment on the cytology of the prostatic smear

Papanicolaou (1949) was the first to claim that shortly after the commencement of oestrogen therapy the prospect of finding malignant cells in the prostatic smear after massage was greatly enhanced owing to increased exfoliation. This experience has been confirmed by others but is not general. It has been found that in cases where the first preparation, taken before the institution of oestrogen treatment, yielded no malignant cells, a second one, taken about fourteen days after the commencement of treatment, might give a positive result.

Large numbers of squamous epithelial cells and glycogenic cells are usually found in the smears from cases of prostatic cancer undergoing

257
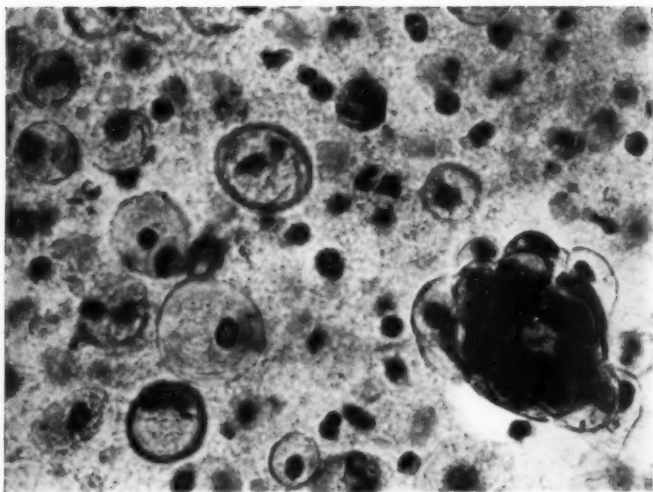
Fig. 13. Prostatic smear showing a clump of malignant cells and a number of glycogenic cells. × 550.
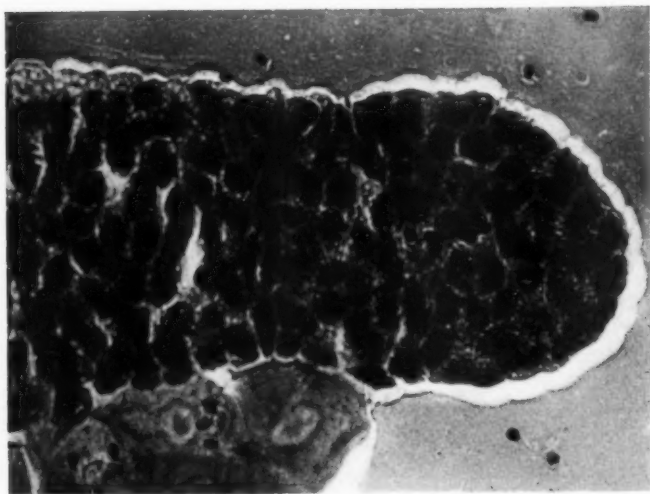
Fig. 14. Malignant prostatic cells in a cast found in the smear after massage. Note the tiny vacuoles at the periphery of the cells—considered to be the result of treatment by stilboestrol. × 550.

258

oestrogen treatment. The glycogenic cells which give a typical iodine reaction are spherical cells with clear cytoplasm, an eccentric nucleus and a doubly-refractile edge (Fig. 13). In microscopic sections of the prostate a considerable proliferation of these cells can be seen in the innocent prostatic acini in the neighbourhood of the urethral orifice.

Various changes in the clumps of malignant cells may be found in the smears. Numerous tiny vacuoles may be seen at the periphery of the individual cells in a cast (Fig. 14). These vacuoles enlarge and coalesce forming large clear spaces of varying size due to the accumulation of glycogen. At the same time degenerative changes, similar to those usually found in necrobiosis, occur in the nuclei of the cells. In one or two smears the malignant cells become fused together forming a mass of cytoplasm of hyaline appearance and containing a number of faintly staining nuclei grouped together at one part (Fig. 15).
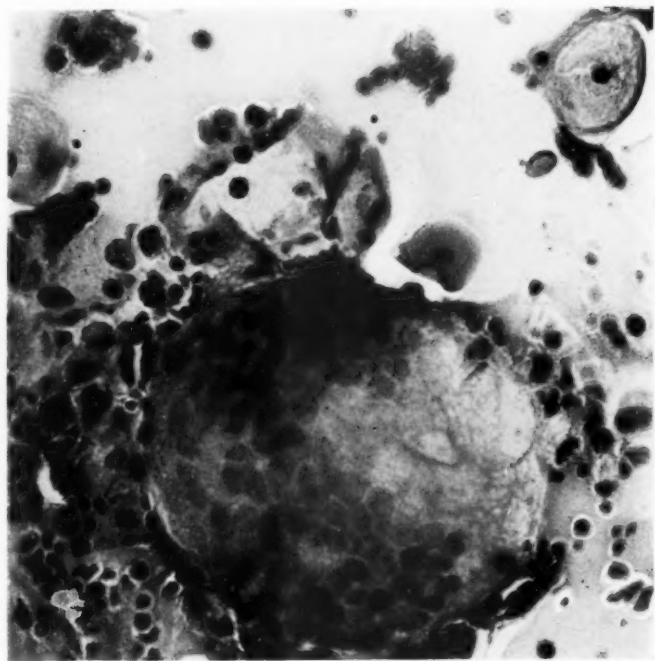
Fig. 15. A mass of cytoplasm of hyaline appearance with a group of faintly staining nuclei at one part—found in groups of malignant cells following stilboestrol therapy. × 550.

259

Fig. 16. Preparations from Mr. Wallace's case :
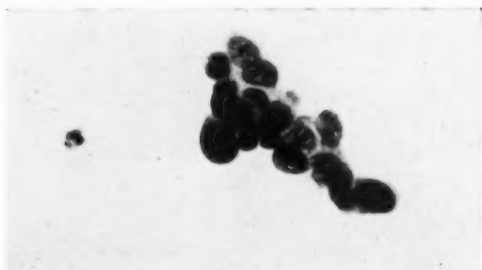
(a) A group of malignant cells in smear obtained after prostatic massage. × 550.
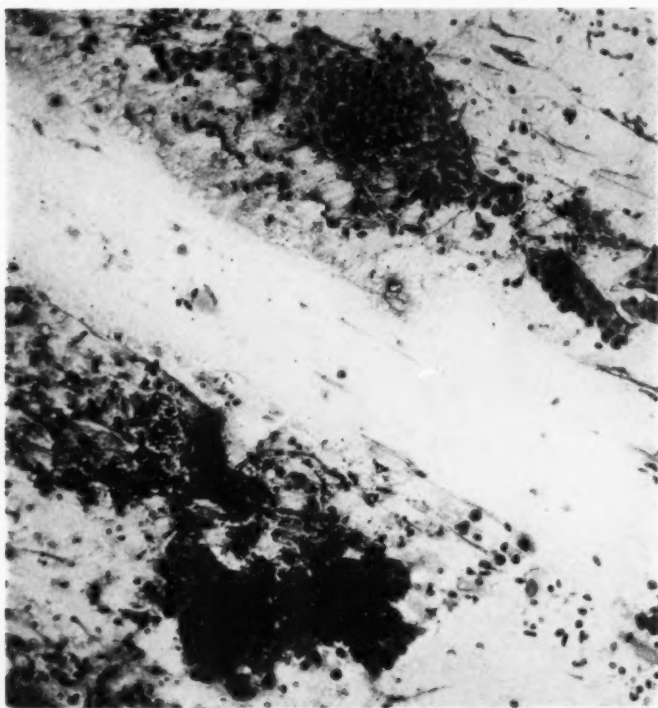
(b) Smear made from prostatic tissue removed at operation—confirming the presence of malignant cells. In this microscopic field innocent cells can be seen in the upper part and malignant cells are present below. × 145.

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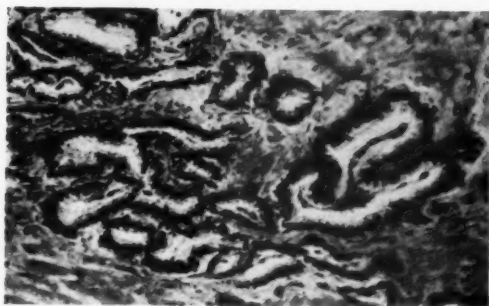
(c)
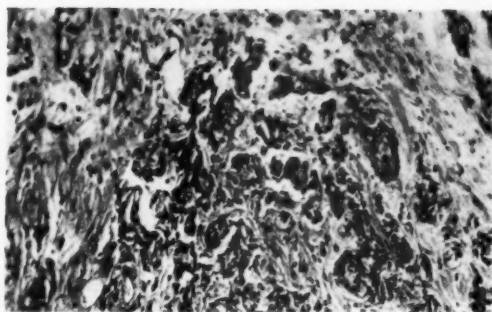
(d)

Fig. 16 (c) and (d) Two areas of a histological section of the prostate showing innocent (c) and malignant (d) tissues corresponding to the appearances seen in Figure 16b. × 145.

" Follow-up " of cases of suspected carcinoma of the prostate

There are great difficulties in the follow-up of cases suspected of having carcinoma of the prostate. The patients belong to an age group in which death is likely to occur from causes quite unrelated to the prostate, and often no relevant information is available. Positive cytological reports have been accepted as correct only when confirmed by histological examination or by the development of metastases—usually shown by X-ray. Tissue for histological examination may be obtained from biopsy, from prostatectomy or from autopsy. In many cases, however, there is no biopsy and operation is neither contemplated nor performed. Moreover, unless every part of the prostate is examined it is impossible, with certainty, to exclude a diagnosis of carcinoma. In view of the fact that in most cases carcinoma starts in the outer part of the gland this applies especially to perurethral biopsy. Better results have been claimed for perineal biopsy by some authorities. When the whole organ is available

261

for examination, following prostatectomy, it is not always possible, especially in early cases, to recognize the malignant condition and with the naked-eye to select pieces for section ; to prepare sections from the entire organ as a routine procedure would generally be impracticable. I would suggest, therefore, that the prostate be cut into a series of slices and from the surface of each one or two smears be made by scraping with a scalpel. Such smears could be fixed and stained in the same way as those obtained by massage (see page 249). As a result of the cytological examination of the smears, suitable portions can be chosen for section and the following case illustrates this procedure :

A patient under the care of Mr. D. M. Wallace was admitted to hospital complaining of urinary obstruction due to an enlarged prostate which was considered clinically to be malignant.

The smear obtained by massage showed clumps of malignant cells (Fig. 16a).

A punch operation was performed and smears made from the cut surface of one or two of the punchings showed clumps of innocent and malignant cells (Fig. 16b).

Histological examination confirmed the diagnosis (Figs. 16c and d).

RESULTS

The results of the investigation of the cytological diagnosis of prostatic carcinoma by prostatic smears are shown in the following table :

Total number of cases in which smears were examined		513
Discarded as inadequate for cytological examination	177	
Reported " negative "	176	
*Reported " positive " (121) ⎰		
or " suspicious " (39) ⎱	160	
		513
*Confirmed by histological examination or by development of metastases detected by X-rays ..		70
" Positive " reports	62	
" Suspicious "	8	
	70	
Sub judice	90	
	160	

In this series of 336 cases examined by cytology, 176 have been reported negative and 160 positive or " suspicious " of malignancy. A number of the negative reports have already been proved to be false and this number will tend to increase. To date the great majority would appear to be correct but it is impossible to give accurate figures. Of the 160 cases reported as positive or suspicious, ninety have been classified as *sub judice*. Of these ninety cases a small number—difficult to determine with certainty —has been falsely reported. In one instance several large clumps of cells from the seminal vesicles, in the absence of spermatozoa, were regarded as malignant prostatic cells. In two cases in which clumps of cells were found in the smear showing the typical crowding of malignant cells, histological examination of the prostate showed a marked epithelial hyperplasia of the cells of the acini but without positive evidence of malignancy—a condition comparable with chronic proliferative mastitis.

One patient was found to have tuberculous prostatitis apparently associated with proliferation of the acinar epithelial cells. Re-examination, however, revealed typical tuberculous giant cells. No section of the prostate was obtained.

The majority of the *sub judice* group of ninety cases still awaits confirmation which may never be obtained. Most of them are regarded on clinical grounds as being definite cases of carcinoma. In some, high values for serum-acid phosphatase, good evidence when present, lend support to the diagnosis. Moreover, the collections of malignant cells found in most of the smears closely resemble, and in many cases are identical in appearance with, those found in the cases of histologically proved carcinoma as illustrated in this paper. There is yet another possibility. Some of these cases, as suggested by Posthuma (1954) may be cases of latent carcinoma. There is no apparent reason why the cells of latent carcinoma should not be exfoliated as in the clinically active disease but a considerable interval of time may be required before this statement can be substantiated.

In a recent paper Frank and Scott (1958) report the results obtained from the examination of 10,410 smears from 2,445 patients in whom the preparations were classified according to Papanicolaou's method (1954). Class I and Class II smears show no evidence of malignancy. In 296 patients there were seventy Class III smears suggestive but not conclusive of malignancy, 159 Class IV smears strongly suggestive, and sixty-seven Class V smears conclusive of malignancy; of these, fifteen, sixty-six and thirty-six respectively were proved histologically to be malignant. In thirteen, sixty-three and twenty-eight cases respectively there was definite evidence of carcinoma either clinically from X-ray appearances or from laboratory investigations. These results are comparable, I think, with those reported in this present paper. As a result of these investigations, notwithstanding the initial difficulty in obtaining suitable preparations, I consider that the cytological examination of smears can be a valuable aid in the diagnosis of carcinoma of the prostate.

ACKNOWLEDGMENTS

REFERENCES

DUDGEON, L. S., and BARRETT, N. R. (1934) *Brit. J. Surg.* **22**, 4.
———————— and PATRICK, C. V. (1927) *Brit. J. Surg.* **15**, 250.
FERGUSSON, J. D., and GIBSON, E. C. (1956) *Brit. med. J.* **1**, 882.

FOOT, N. C., PAPANICOLAOU, G. N., HOLMQUIST, N. D., and SEYBOLT, J. F. (1958)
Cancer 11, 127.
FRANK, I. N., and SCOTT, W. W. (1958) J. Urol. 79, 983.
FRANKS, L. M. (1954) J. Path. Bact. 68, 603.
HERBUT, P. A., and LUBIN, E. N. (1947) J. Urol. 57, 542.
MULHOLLAND, S. W. (1931) Proc. Staff Meet., Mayo Clin. 6, 773.
PAPANICOLOAU, G. N. (1949) Ann. Int. Med. 31, 661.
———————————— (1954) Atlas of exfoliative cytology: Commonwealth Fund,
Harvard Univ. Press : p. 21.
PETERS, H. (1950) Cancer 3, 481.
POSTHUMA, J. (1954) in Clinical Cytology by Cardozo, pub. Leyden.
YOUNG, J. S. (1953) Lancet 2, 1131.

IMPERIAL CANCER RESEARCH FUND

THE IMPERIAL CANCER Research Fund announces that Dr. J. Craigie, F.R.S., has resigned his post as Director of the Fund's Mill Hill Laboratories so that, free from administrative duties, he can devote himself entirely to cancer research in the laboratories. His invaluable advice on research will therefore continue to be available to the Fund.

Dr. R. J. C. Harris, Ph.D., joined the Fund's scientific staff on 1st October 1958 to take up a new appointment as Head of the Division of Experimental Biology and Virology. He will be responsible (under the Director, Dr. G. F. Marrian, F.R.S.), for the general administration of the Mill Hill Laboratories.

Dr. A. R. Currie, B.Sc., M.B., B.Ch., F.R.C.P.(Ed.), at present Assistant Pathologist at the Royal Infirmary, Glasgow, has been appointed Head of the Division of Pathology and will take up his duties on 1st October 1959. The Fund is meanwhile giving financial support to the cancer research he is undertaking in the pathology department of the University of Glasgow.

Mr. A. Dickson Wright, M.S., F.R.C.S., will make an appeal on behalf of the Imperial Cancer Research Fund in the B.B.C.'s programme on the Home Service " The week's good cause " on Sunday, 23rd November 1958, at 8.25 p.m.

APPOINTMENT OF FELLOWS AND MEMBERS TO CONSULTANT POSTS

A. L. T. EASTON, M.D., F.R.C.S., M.R.C.O.G., Consultant Obstetric and Gynaecological Surgeon, The London Hospital.

SCIENTIFIC MEETING OF THE FACULTY OF ANAESTHETISTS, ON "SHOCK AND ALLIED PHENOMENA"

held at the Royal College of Surgeons of England

on
14th June 1958

OPENING SPEECH

by

Sir Henry H. Dale, O.M., G.B.E., F.R.C.P., F.R.S.

I AM GREATLY obliged to Dr. Frankis Evans, and to the other members of your Faculty, for the honour of the invitation to make a contribution to this discussion on " Shock and Allied Conditions," in the form of an opening statement, and for the opportunity, with which I am thus provided, of recalling something of the views and speculations about shock which were current many years ago, when I was called upon to take part in investigations concerning its nature and the measures for treating it. You may all be sure that I am looking forward with eager interest to hearing what members of your Faculty, and other participants in the discussion, are thinking to-day about " Shock and Allied Conditions." For my own part, I cannot claim to contribute more than some memories of what must, I suppose, for the most part be passing already into ancient history.

More than forty years have passed, in fact, since I found myself called upon to take part in, and to help in organizing researches on shock and its treatment, to meet the growing emergency, with which the surgeons working with the armies in France found themselves called upon to deal, soon after the beginning of the First World War. Few of them had had much previous experience of dealing with surgical or traumatic shock, and none of them had previously encountered it on such a portentous scale.

We first tried, on behalf of a committee organizing research in London and interchanging views and experience with surgeons working at the casualty clearing stations and in base hospitals, to arrive at a consistent definition of what was being termed shock ; but the only one on which we could obtain agreement seemed to be reached to a process of exclusion, rather than by a positive description of characteristic features. A condition of severely depressed vitality, with a deficient circulation as its central feature, could obviously be the result of various factors, when observed in men wounded or otherwise injured in the stress of modern warfare. It appeared to be diagnosed as " shock," only if there was no clear record or evidence of a haemorrhage, or an acute infection, sufficient to account for it. " Shock," we used to say, " seems rather to be a diagnostic dumping-ground for the surgeon, than a clearly recognizable,

clinical entity." I shall be on the look-out now, in listening to your discussion, for indications of the extent to which medicine in general, and the Faculty of Anaesthesia in particular, has been able to progress from that rather sceptical attitude towards a clearer and more positive definition of what is meant by shock.

As our war-time enquiries proceeded, and as communications became easier with the relative stabilization of trench-warfare, we learned that the term " shock " was apt to be applied, rather confusingly, to two conditions which could usually be distinguished as obviously different, though they might become continuous with one another in certain cases.

1. There was the sudden failure of vitality due to reflex inhibition of the heart-beat, and of the vasomotor tone required to sustain the arterial pressure. The phenomenon seemed to be clearly a severe example of what, in civilian life, would have been termed a fainting-fit. Recovery from it was normally spontaneous, or promoted by conventional restorative measures. It was early agreed that this relatively evanescent condition should be referred to as " collapse " to distinguish it from the other more ominous and ingravescent condition, for which the term " shock " should be reserved. The normally less serious " collapse " might obviously become continuous with the more serious " shock " in the absence of a sufficiently prompt recovery.

2. It was the secondary, ingravescent and frequently fatal condition of " wound-shock " which we were called upon specially to investigate. There were several lines of evidence which suggested that at least a central factor in its causation was the absorption of something toxic from the injured tissues.

This evidence put the committee, working in London, on the alert in more than one direction. A suggestion which, for a time, was strongly supported by some of the members, was based on the consideration that the tissues damaged in injuries of the massive type, which were most liable to cause shock, usually included large quantities of muscle. It was urged that injury of muscles, in particular, would cause the liberation of such quantities of lactic acid as might produce a serious depression of the " alkali reserve " of the blood-plasma. This had then been much under recent discussion in America, and American surgeons and physiologists, who had come early to work as volunteers with the British Armies, had brought with them examples of Professor Van Slyke's simple apparatus for determining the alkali-reserve. News was soon received from the casualty clearing stations of measurements made there on wounded men suffering from shock, which demonstrated that the alkali-reserve in the blood of such cases was, indeed, notably depressed. Professor W. B. Cannon, of Harvard, who had been making physiological observations in connection with Colonel (later Sir) Cuthbert Wallace's surgical team at a casualty clearing station, came back to London, to put his observations made there on the depression of the alkali-reserve in the shock of

wounded men, to the test of deliberate experiments on animals, made in collaboration with Sir William Bayliss at University College, London. By experiments on cats, under stable anaesthesia with the then commonly used urethane, they had convinced themselves that the direct reduction of the alkali-reserve of the blood plasma below a certain " critical level," by an intravenous infusion of an acid saline solution, produced a condition of eventually fatal " shock," with a seriously and permanently depressed circulation. Professor A. N. Richards, of Philadelphia, had meanwhile come over to work with me, and, by otherwise parallel experiments, in which we had also reduced the alkali-reserve by the infusion of acid, but in cats anaesthetized with ether, the administration of which could be reduced in accordance with the observed need for it, we convinced ourselves and, eventually, our colleagues Bayliss and Cannon that the reduction of the alkali-reserve of the plasma could not, by itself, produce a condition in any way suggestive of shock. To settle the matter we made an experiment jointly with them, in which we found that, when only a local anaesthetic was used to prepare a vein for the infusion of the acid, the alkali-reserve could be reduced to a very low level without producing any shock-like failure of the circulation.

The attention of our committee was thereby directed to the significance of experiments which Professor Richards and my own associate in more than one connection, Dr. (later Sir) P. P. Laidlaw, had been carrying out with me on the production, by injections of histamine, of a condition which showed, in several directions, at least a suggestive similarity to the so-called " secondary wound shock," which was causing so much trouble and anxiety in the advanced military hospitals. In both cases, in wound shock and histamine shock, the failure of the circulation appeared to be caused, not by weakness of the heart-beat, or by lack of arterial tone, but by a severe oligaemia—a deficient volume of blood in effective currency, which, in turn, was due to the stagnation of a large proportion of the blood at the periphery, in the generally and simultaneously relaxed capillary vessels of the whole network, together with a leakage of plasma through their abnormally permeable walls, causing a corpuscular concentration.

It seemed worth while to us then, and in the immediately following years, to study the conditions which would render an animal susceptible to the shock-producing effect of a few milligrammes of histamine, in the hope that this would throw light, if only by analogy, on the conditions conducive to the production of shock by the absorption into the circulation of various products of protein cleavage, in consequence of severe and massive tissue injuries. I think that a rather more detailed consideration of some of the conditions, which we found thus to be conducive to the production of a shock-like condition by histamine, may have a special interest for your Faculty.

1. Histamine, administered by intravenous infusion to an unanaesthetized cat could, apparently, be tolerated in almost indefinite amounts—up to

267

10 milligrammes per kilo. If the experiment was made, however, with a cat—even with the same cat, indeed, on a subsequent occasion—under the influence of one of the then conventional anaesthetics, chloroform, ether, urethane, 1 or 2 milligrammes of histamine per kilo produced an irremediable shock of the type described. If a cat, after being kept under ether for an hour or two, was then allowed even to recover consciousness and activity, intravenous histamine, given soon afterwards, still produced the typical shock. The sensitization was clearly not due just to the *state* of anaesthesia, but to a more persistent effect of the anaesthetic *agent*. Of anaesthetics then available, only $N_2O + O_2$ appeared to be free from this histamine-sensitizing action. This experience corresponded closely with that of surgeons with the army. They had found that a badly wounded man, even if he showed no signs of shock already, was tragically apt to develop it, if he was anaesthetized with chloroform, or ether, for some necessary operation ; only anaesthesia with $N_2O + O_2$ was free from this danger. I need not suggest to your Faculty that the whole position, with regard to the agents and methods of anaesthesia has undergone a revolutionary, and, of course, a still progressive improvement, during the past few decades ; whereas, by the time to which I have been referring, that of the First World War, methods of anaesthesia had neither made, nor given, indeed, any serious promise of making any important advance since the days of Morton and Simpson. We shall hear to-day, I hope, something about the relation to the incidence of shock of the use of the modern, stable anaesthetic agents, barbiturates and others, and of the various agents blocking different kinds of efferent and afferent nerve-impulses, and of all the more elaborate and effective methods now available to the anaesthetist.

2. An antecedent bleeding of any severity—say by one third of the calculated blood-volume—would act, like anaesthesia, as a factor conducive to the production of shock by an otherwise harmless dosage of histamine. This, I suppose, is not so directly the affair of the anaesthetist ; but he may, perhaps, regard it as his concern, to the extent of hoping that the surgeon will not, by indifference to avoidable haemorrhage, bring the anaesthetic or its administrator under suspicion, in connection with any resulting shock.

3. Removal of the suprarenal glands had a most impressive effect, in producing an extreme sensitiveness of cats to the shock-producing action of histamine. Within twenty-four hours of the removal, long before the animal showed any overt symptoms of the deprivation, a slow infusion of histamine, without anaesthesia, not only produced the typical shock, but produced it by the time that the amount administered was no more than a small fraction of that which was normally required to produce such a shock, even under full anaesthesia. I suspected, even then, that it was lack of the cortex, rather than lack of the medulla, which was responsible ; and all the wealth of knowledge concerning the cortex and its hormones which has since accumulated, has fully confirmed that

suspicion. Cortico-sterone appears somehow to be requisite to enable the capillaries to resist the effects of substances which, like histamine, relax the tone of their walls and render them abnormally permeable to the blood plasma.

I am glad to see, indeed, that you have, on your programme to-day, a communication on " adrenocortical shock " by Dr. Bayliss, and others on " pharmacological aspects of shock," on " ganglionic blockade and shock," on " prevention and treatment of wound shock " and on " trauma, shock and the anaesthetist." Your programme as a whole, indeed, gives me the pleasant impression that problems, in which I had the privilege of collaborating with so distinguished a group of investigators, including the late Professor Cannon of Harvard, Professor A. N. Richards of Philadelphia, and the late Sir William Bayliss, as well as my own more intimate colleague the late Sir Patrick Laidlaw, as long ago as the First World War, are still matters of interest to and discussion by your Faculty of Anaesthetists, with all the immense accession of relevant knowledge and facilities, which have become available in the intervening period. I specially welcome your interest in these matters as an additional indication, if such were needed, of the remarkable and still rapidly progressive enlargement, of the sphere of interest and responsibility now regarded as appropriate to the surgical anaesthetist. When I entered upon the clinical stage of my studies, at the beginning of the century, the only anaesthetic procedure, on which I received any deliberate instruction, was the dropping of chloroform on a fold of lint held over the patient's face ; and my conception of the anaesthetist's function was correspondingly restricted. But, in these latter days, the possibilities and, consequently, the requirements of surgery are apparently being constantly extended, by the use of all sorts of physiological controls and contrivances— artificial, mechanical maintenance of the circulation and of the respiration, pharmacological blocking of ganglia, of motor end-plates, or of other synaptic junctions, and many other interferences, entailing a rapid and revolutionary development of the anaesthetist's responsibility for the physiological safety of the whole patient, leaving the surgeon to work with concentration and confidence on one special item, or system, of the patient's anatomy. A few years ago I saw an operation at the Mayo Clinic, and noted with interest that the surgeon had just two surgical assistants, in addition to two nurses threading needles, while the anaesthetist had a team of twelve experts, each of them engaged with the management of a different item of physiological mechanism, or control. More and more, then, of the responsibility for keeping the patient alive, and for avoiding factors conducive to shock, must be accepted by the anaesthetist.

I am sure you are going to have an important and enlightening discussion. I am looking forward to it with great interest ; and, once again, I offer my thanks to all concerned, for the privilege of being invited to make these opening remarks.

22

In Memoriam

SIR VICTOR HURLEY
K.B.E., C.B., C.M.G., M.S., F.R.C.S., F.R.A.C.S.

ON 17TH JULY died a famous Melbourne surgeon, Sir Victor Hurley. Born in 1888, " Vic " Hurley had attained the Biblical three score years and ten and had crowded much into his active life. His early educative years were spent at Wesley College, Melbourne, and at " Queens " ; he

Sir Victor Hurley

was a member of a famous undergraduate year at Melbourne University, which included men like the late Sir Alan Newton and the ever active Sir William Upjohn. Hurley was a highly competent surgeon, not of the

270

" daimonic " type, sweeping aside former well-tried methods and urging
new ones, not the pioneer, but the man whose care of his patient was a
sacred trust.

Excellent surgeon though he was—I first met him in 1917 as a surgeon
in an Australian casualty clearing station, where he had already established
a reputation—perhaps he was best known for his real flair for administra-
tion, and from the time he became Assistant Director Medical Services,
Australian Imperial Forces in the latter part of the First World War he
filled a succession of responsible offices, which included the presidencies
of the Royal Australasian College of Surgeons and of the Federal Council
of the British Medical Association ; he was head of the R.A.A.F. Medical
Services during the Second World War, and for a time was chairman of
the Australian Red Cross Society. His connection with the Royal
Melbourne Hospital was a long and honourable one : finally, he became
its president and also chairman of the board of the Walter and Eliza Hall
Institute. He was not directly interested in research, but was fully aware
of its importance " as a leaven to the hospital's direct responsibilities "
for the care of the sick and undergraduate and postgraduate teaching.

Like Henry Newland, Hugh Devine, Harold Dew and Henry Searby,
he was honoured by British surgery by his election as an Honorary Fellow
of the Association of Surgeons of Great Britain and Ireland.

His home life was singularly happy, for he was married to a charming
lady who survives him, and he leaves four sons and two daughters,
several being members of the medical profession.

G. G.-T.

GUILDFORD CATHEDRAL

Doctors' Window

THE FOLLOWING IS an extract from a letter received from Dr. G. I. Watson,
Chairman of the Guildford Division of the British Medical Association :

"As you are no doubt aware, the new Cathedral in Guildford is nearing
completion, and the Guildford Division of the British Medical Association has
undertaken to raise sufficient funds to provide one of the lancet windows as a
gift from the medical profession.

" There must be many members of your College who know Guildford well
or who cherish memories of some incident connected with their work or
recreation, which took place in Surrey.

" To these particularly, and to all other doctors with whom you are in touch,
I should be most grateful if you would pass on our appeal for funds, so that we
may grasp successfully this opportunity to honour both the profession and our
beautiful Cathedral.

" Their donations should be sent to " The Doctors' Cathedral Window Fund,"
c/o Dr. F. A. Belam, 1, Westfield, Epsom Road, Guildford, Surrey, who is
Treasurer of the appeal."

271

23

THURSDAY, 23rd October, at 5 p.m.

TUESDAY, 28th October, at 3.45 p.m.
"Animal colour."
THURSDAY, 30th October, at 5 p.m.
" Barber-Surgeons in Great Britain and Ireland."
THURSDAY, 6th November, at 5 p.m.
" Carcinoid tumours (argentaffinomata)."
THURSDAY, 13th November, at 5 p.m.
" Spondylolisthesis : spinal strain."
TUESDAY, 18th November, at 3.45 p.m.
" Joint movements and muscle actions."
THURSDAY, 20th November, at 5 p.m.

THURSDAY, 27th November, at 5 p.m.
" Lobectomy and bronchial anastomosis in the surgery of bronchial carcinoma."
TUESDAY, 2nd December, at 5 p.m.
" The closing mechanism between stomach and oesophagus and its importance in surgery of the gastro-oesophageal junction."
THURSDAY, 4th December, at 5.30 p.m.

TUESDAY, 9th December, at 5 p.m.

THURSDAY, 11th December, at 5 p.m.

THURSDAY, 8th January, at 5 p.m.
" Congenital anomalies of the urinary tract in relation to disorders of micturition."
THURSDAY, 15th January, at 3.45 p.m.

THURSDAY, 22nd January, at 5 p.m.
" Pathological ossification in nervous disease with special reference to traumatic paraplegia."
TUESDAY, 27th January, at 5 p.m.

THURSDAY, 29th January, at 5 p.m.
" The surgical treatment of speech disorders."
TUESDAY, 3rd February, at 5 p.m.
" The anatomy and physiology of the bile and pancreatic ducts and their surgical significance."
THURSDAY, 5th February, at 3.45 p.m.

THURSDAY, 5th February, at 5.30 p.m.

MONDAY, 16th February, at 4 p.m.

THURSDAY, 19th February, at 3.45 p.m.

TUESDAY, 24th February, at 5 p.m.

THURSDAY, 26th February, at 5 p.m.
" Non-malignant bile duct obstruction."
TUESDAY, 3rd. March, at 5 p.m.
" The gubernaculum testis Hunteri, testicular descent and maldescent."
THURSDAY, 5th March, at 5.30 p.m.

TUESDAY, 10th March, at 3.45 p.m.

THURSDAY, 12th March, at 5 p.m.
" The micro-anatomy of the breast."

ERASMUS WILSON DEMONSTRATION
by Dr. K. M. Laurence.
ARNOTT DEMONSTRATION
by Dr. A. A. Barton.
THOMAS VICARY LECTURE
by Sir John McNee.

HUNTERIAN LECTURE
by Prof. A. J. Davies.
ROBERT JONES LECTURE
by Mr. Norman Capener.
ARNOTT DEMONSTRATION
by Prof. R. J. Last.
ERASMUS WILSON DEMONSTRATION
by Dr. H. A. Sissons.
HUNTERIAN LECTURE
by Prof. P. H. Jones.

HUNTERIAN LECTURE
by Prof. G. S. M. Botha.

OTOLARYNGOLOGY LECTURE
by Sir Stanford Cade.
ERASMUS WILSON DEMONSTRATION
by Dr. L. W. Proger.
BRADSHAW LECTURE
by Sir Archibald McIndoe.
HUNTERIAN LECTURE
by Prof. R. A. Mogg.

ARNOTT DEMONSTRATION
by Dr. B. Cohen.
HUNTERIAN LECTURE
by Prof. J. W. Dickson.

ERASMUS WILSON DEMONSTRATION
by Dr. R. C. B. Pugh.
HUNTERIAN LECTURE
by Prof. J. S. Calnan.
ARRIS AND GALE LECTURE
by Mr. Rodney Smith.

ARNOTT DEMONSTRATION
by Dr. R. McP. Livingston.
OTOLARYNGOLOGY LECTURE
by Mr. Victor Riddell.
HUNTERIAN ORATION
by Sir Reginald Watson-Jones.
ARNOTT DEMONSTRATION
by Dr. A. Howe.
ERASMUS WILSON DEMONSTRATION
by Dr. R. A. Goodbody.
HUNTERIAN LECTURE
by Prof. C. Havard.
ARRIS AND GALE LECTURE
by Dr. K. M. Backhouse.

OTOLARYNGOLOGY LECTURE
by Mr. Robert Brain.
IMPERIAL CANCER RESEARCH FUND LECTURE
by Mr. P. C. Williams.
HUNTERIAN LECTURE
by Prof. A. G. Parks.

TUESDAY, 17th March, at 5 p.m.	ERASMUS WILSON DEMONSTRATION by Dr. M. O. Skelton.
WEDNESDAY, 18th March, at 4 p.m.	FREDERIC HEWITT LECTURE by Dr. C. Langton Hewer.
THURSDAY, 9th April, at 5 p.m. "Congenital deformities of the hand."	HUNTERIAN LECTURE by Prof. T. J. S. Patterson.
TUESDAY, 14th April, at 5 p.m. "The anatomy, physiology and pathology of the human amnion and chorionic membranes."	ARRIS AND GALE LECTURE by Mr. G. L. Bourne.
TUESDAY, 28th April, at 3.45 p.m.	ARNOTT DEMONSTRATION by Miss J. Dobson.
THURSDAY, 30th April, at 5.30 p.m.	OTOLARYNGOLOGY LECTURE by Prof. M. A. Rushton.
FRIDAY, 1st May, at 5 p.m. "Hormone deprivation in breast cancer spontaneously arising or surgically induced."	HUNTERIAN LECTURE by Prof. G. J. Hadfield.
THURSDAY, 2nd July, at 5.30 p.m.	OTOLARYNGOLOGY LECTURE by Dr. Dennis Hill.

The Lectures and Demonstrations are open to those attending Courses in the College and also to all other Medical Practitioners, Dental Surgeons and Advanced Students.

DIARY FOR OCTOBER

Wed. 15   Final L.D.S. Examination (Part II) begins.
9.30   DR. J. GILLIES—Prevention, treatment and medico-legal aspects of anaesthetic accidents.
11.00   DR. J. GILLIES—Anaesthesia for emergency surgery—I.
12.00   DR. J. GILLIES—Anaesthesia for emergency surgery—II.
2.00   PROF. W. D. M. PATON—The paralysis of autonomic ganglia.
3.30   PROF. W. D. M. PATON—Histamine, hydroxytryptamine and their antagonists.
5.00   Board of Faculty of Anaesthetists.
5.15   MR. S. M. COHEN—Place of sympathectomy procedures.
6.30   MR. J. CHARNLEY—Fractures of the femur.

Thur. 16   D.M.R.D. Examination (Part I) and D.M.R.T. Examination (Part I) begin.
9.30   PROF. W. W. MUSHIN—Some aspects of physics in relation to anaesthesia.
11.00   PROF. W. W. MUSHIN—Anaesthesia in disorders of the endocrine system.
5.15   MR. H. R. I. WOLFE—Testicular tumours.
6.30   MR. ASHTON MILLER—Diverticula of the bladder.

Fri. 17   9.30   DR. J. F. NUNN—Acid base balance changes in anaesthesia.
11.00   DR. J. A. LEE—Special aspects of spinal and epidural anaesthesia.
2.00   DR. R. BRYCE SMITH—Anaesthesia and analgesia in obstetrics.
3.30   DR. R. BRYCE SMITH—An appraisement of local analgesic procedures.
5.15   MR. G. C. KNIGHT—Cervical disc lesions.
6.30   MR. R. SHACKMAN—Non-tuberculous urinary infections.
Course in clinical surgery and surgical lectures and clinical conferences end.

Mon. 20   9.30   DR. J. B. WYMAN—The dry field in surgery.
11.00   DR. J. G. BOURNE—Anoxia.
2.00   MR. L. P. LE QUESNE—Fluid balance—I.
3.30   MR. L. P. LE QUESNE—Fluid balance—II.

Tues. 21   9.30   DR. H. C. CHURCHILL-DAVIDSON—Principles of hibernation and hypothermia—I.
11.00   DR. H. C. CHURCHILL-DAVIDSON—Principles of hibernation and hypothermia—II.
2.00   DR. R. P. W. SHACKLETON—The management of apnoeic patients.
3.30   DR. G. H. TOVEY—Transfusion therapy.

23—2

Wed. 22	9.30	Dr. T. C. Gray—Mechanisms of neuromuscular block.
	11.00	Dr. T. C. Gray—Muscle relaxants in anaesthetic practice—I.
	12.00	Dr. T. C. Gray—Muscle relaxants in anaesthetic practice—II.
	2.00	Dr. G. Jackson Rees—Anaesthesia for children—I.
	3.30	Dr. G. Jackson Rees—Anaesthesia for children—II.
Thur. 23		D.M.R.D. Examination (Part II) begins.
	9.30	Dr. T. H. S. Burns—The fire and explosion hazard in anaesthesia.
	11.00	Prof. A. Kekwick—The assessment of cardiovascular disease.
	5.00	Dr. K. M. Lawrence—Erasmus Wilson Demonstration—The pathology of hydrocephalus.*
Fri. 24	9.30	Dr. A. I. Parry Brown—Anaesthesia for thoracic surgery.
	11.00	Dr. A. I. Parry Brown—Anaesthesia for cardiac surgery.
	2.00	Dr. J. Vane—The actions of analeptics.
	3.30	Dr. R. M. Davies—Anaesthesia for plastic surgery. Anaesthetic course ends.
Mon. 27		Dental Lectures and Clinical Conferences begin.
Tues. 28		Final Fellowship Examination (Ophthalmology and Otolaryngology) begins.
	3.45	Dr. A. A. Barton—Arnott Demonstration—Animal colour.*
	5.00	Mr. Terence Ward—Fractures of the Facial Bones—I.
	6.15	Dr. V. Goldman—General anaesthesia—I.
Wed. 29		Primary F.R.C.S. Examination begins.
Thur. 30		Thomas Vicary Commemoration.
	5.00	Sir John McNee—Thomas Vicary Lecture—Barber-Surgeons in Great Britain and Ireland.*
		D.Path. Examination and D.M.R.T. Examination (Part II) begin.
	5.00	Mr. T. Ward—Fractures of the Facial Bones—II.
	6.15	Dr. V. Goldman—General anaesthesia—II.

DIARY FOR NOVEMBER

Tues. 4		Final Fellowship Examination (General Surgery) begins.
	5.00	Mr. B. Cohen—Secondary tumours of the jaws.
	6.15	Mr. S. H. Wass—Osteomyelitis of the jaws.
Wed. 5		D.T.M. & H. Examination begins.
Thur. 6	5.00	Prof. A. J. Davies—Hunterian Lecture—Carcinoid tumours (argentaffinomata).*
	5.00	Mr. N. L. Rowe—Soft tissue infections of the face and neck.
	6.15	Mr. P. Clarkson—Surgical correction of deformities of the jaws.
Tues. 11	5.00	Prof. E. D. Farmer—Oral ulcers.
	6.15	Mr. B. E. D. Cooke—Fibro-osseous swellings of the jaws—I.
Wed. 12	7.30	Monthly Dinner.
Thur. 13		D.A. Examination begins.
	2.00	Council.
	5.00	Mr. N. Capener—Robert Jones Lecture—Spondylolisthesis : spinal strain.*
	5.00	Mr. B. W. Fickling—The maxillary antrum in relation to dental surgery.
	6.15	Mr. B. E. D. Cooke—Fibro-osseous swellings of the jaws—II.
Tues. 18	3.45	Prof. R. J. Last—Arnott Demonstration—Joint movements and muscle actions.*
	5.00	Dr. W. Campbell—Radiology of the facial bones—I.
	6.15	Mr. J. Watson—Head injuries.
Thur. 20	5.00	Dr. H. A. Sissons—Erasmus Wilson Demonstration.*
	5.00	Dr. W. Campbell—Radiology of the facial bones—II.
	6.15	Mr. C. R. McLaughlin—The cleft palate.
Fri. 21	5.00	Board of Faculty of Dental Surgery.
Tues. 25	5.00	Prof. R. B. Lucas—Pathology of Oral Neoplasms—I.
	6.15	Dr. L. Forman—Oral manifestations of skin diseases—I.
Wed. 26		First L.D.S. Examination begins.
Thur. 27		D.P.M. Examination (Part I) begins.
	5.00	Prof. P. H. Jones—Hunterian Lecture—Lobectomy and bronchial anastomosis in the surgery of bronchial carcinoma.*
	5.00	Prof. R. B. Lucas—Pathology of Oral Neoplasms—II.
	6.15	Dr. L. Forman—Oral manifestations of skin diseases—II.
		* Not part of courses.

LIST OF "OBSERVABLES" DESCRIBED IN THE ANNALS
JULY 1947-JUNE 1958

*The first number shows the volume; the second number shows the monthly
issue; the third number shows the page.*

LONDON MEDICAL EXHIBITION 1958

NOVEMBER 10th to 14th
Daily from 11 a.m. to 6.30 p.m. (7.30 p.m. Thurs.)

NEW HALL, ROYAL HORTICULTURAL SOCIETY
Greycoat Street, Westminster, S.W.1

Opening Ceremony

The official opening ceremony will be performed by Sir Roy Cameron, F.R.C.P., F.R.S., Professor of Morbid Anatomy at University College Hospital Medical School in the University of London, and will take place at 11.30 a.m., Monday, 10th November.

Exhibits will cover a very extensive field of medical interest and will include the latest developments in ethical medical products, as well as a most interesting and wide range of apparatus of a professional nature for the Physician and Surgeon. Attendance is confined to members of the Medical and allied Professions. Films of professional interest will be shown each day in the Film Theatre. Official personal invitations will be posted to members of the Profession, and if not received by 31st October, please apply to :

The Secretary, LONDON MEDICAL EXHIBITION
194-200, Bishopsgate, London, E.C.2
Telephone: AVEnue 1444/5

The fully revised 1958/59 edition of THE LONDON MEDICAL HANDBOOK (with therapeutic index) will be available to Exhibition visitors at a special price of 2s. 6d.

5

RESPIRATORY EMERGENCIES IN THE NEWBORN

Moynihan Lecture delivered at the Royal College of Surgeons of England
on
25th July 1958
by
Willis J. Potts, M.D.
Children's Memorial Hospital, Chicago

FOR THE SIGNAL honour of delivering this Lord Moynihan lecture I am deeply and humbly grateful. Before proceeding to the prosaic business of the lecture I want to carry a message to you, our English friends. Of course, I speak unofficially as an American citizen without portfolio but I know that I echo the sentiments of millions of other average American people who would like with me to underscore the following words : we deeply value our Anglo-Saxon heritage ; we speak your language—just a slightly different accent—we cherish the same principles of freedom ; our fortunes are irrevocably joined together. We admire your tenacity, your bulldog perseverance, even your delightful stubbornness. Above all, we revere your dauntless courage. Eighteen years have passed since the relentless enemy bombing of your cities and the dark days of " blood, sweat and tears." We have not forgotten nor will we forget the debt we owe you for not faltering when hope for victory was all but extinguished. For myself and millions at home, again I want to repeat " Thank you."

The newborn child separated from its parasitic existence and ejected into an individualistic world suddenly is dependent upon its own respiratory system. The lungs, solid and full of fluid to the moment of birth must promptly expand and begin the process of respiration. It is little wonder that the few minutes immediately after birth are the most hazardous period in a person's life. Any abnormality of the respiratory system from mouth to diaphragm accentuates the infant's difficulty in accommodating itself to the new responsibility of breathing.

When observing infants in the nursery with respiratory difficulties one promptly places them into one of two groups : the cyanotic without respiratory distress and the dyspnoeic with or without cyanosis. The former group of persistently cyanotic infants usually have either congenital heart disease or brain injury. Our interest today is not focused upon these problems but rather upon the second group of infants who are simply dyspnoeic or severely dyspnoeic and consequently cyanotic.

Immediately after birth of the infant the obstetrician is mildly concerned with initiation of respiration. That this process ordinarily begins and continues without any help whatsoever is attested to by the fact that so many of us are about. If, however, aspiration of mucus from the pharynx and utilization of simple methods of delivery room resuscitation

275

fail to induce normal breathing, attention should be directed towards the possible cause. Observation of the child's breathing is of the first importance in deciding whether respiratory distress is due to pharyngeal, laryngeal or tracheo-bronchial obstruction or to inadequate pulmonary function. Stertorous, coarse, rasping respirations suggest high obstructions due to such conditions as : lingual cysts, micrognathia, macroglossia, supraglottic webs, pharyngeal paralysis, etc. Laryngeal obstruction, far more common, is characterized by rapid laboured breathing, inspiratory stridor, and an abnormal or absent cry. Obstructions below the larynx in the tracheo-bronchial tree cause respiratory or expiratory crowing but the child's cry is normal. We are very dependent upon the endoscopist for assisting in the diagnosis and handling of most of the problems of laryngeal obstruction. Our chief concern as paediatric surgeons is with the problems of respiratory distress which are remediable by surgery or preventable during the post-operative period.

Although observation of the child in respiratory distress and routine physical examination are important, nothing gives more direct information than good roentgenograms which, to be of any value, must be made in the X-ray department. Portable films are usually valueless and often misleading. It is practically always possible to move the child to the X-ray department in an isolette—in oxygen if necessary. Utilizing the apparatus shown in Figure 1, clear anteroposterior and lateral films of the chest can be made of an infant with 1-30 of a second exposure. By holding the child up by its arms the scapulae are moved laterally, the diaphragm is depressed and a good upright film of the chest is obtained and a picture of the abdomen as a dividend. If one suspects that the obstruction is located in the upper air passages a second lateral view is taken with the child upright but with arms down and held behind the back. It seems fair to state rather dictatorially that except for aspiration of the pharynx no active surgical treatment is permissible until one has seen a good roentgenogram.

Responsibility for the care of respiratory emergencies is shared by endoscopist, radiologist, paediatrician and surgeon who quickly pool their findings and opinions in an attempt to establish a diagnosis—an absolute essential for intelligent treatment. A few of the respiratory problems falling to the lot of the paediatric surgeon will be briefly discussed with emphasis placed upon the do's and don'ts of surgical treatment as successes and failures have dictated.

Thyroglossal duct cysts ordinarily seen during early childhood may be large at birth and by pressure produce respiratory obstruction in the supraglottic area. A diagnosis is easily made and surgery is curative. More common and less easily diagnosed, unless one keeps in mind the possibility of it as a cause of dyspnoea, is a thyroglossal duct cyst at the base of the tongue pushing the epiglottis downward and interfering with inspiration. The cyst can be identified by palpation and inspection.
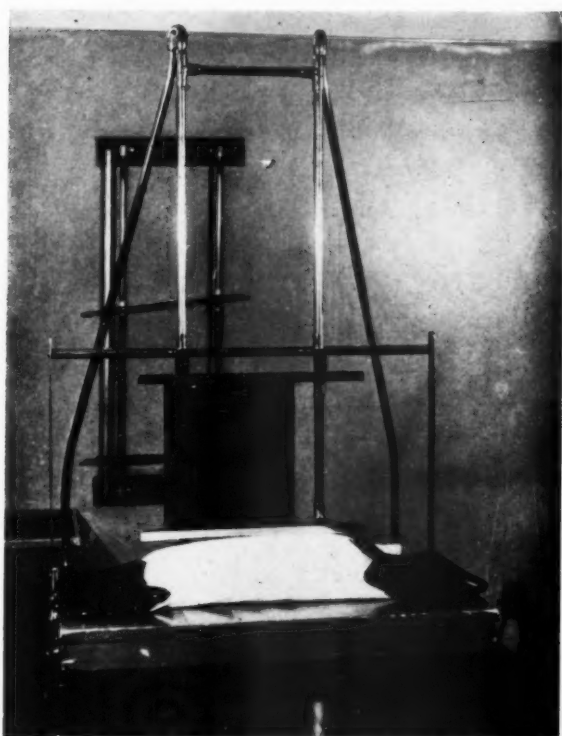
Fig. 1 (a)   Apparatus for holding casette for upright roentgenograms of infants.

Aspiration of a few cubic centimetres of fluid from the cyst promptly restores normal breathing.

In one instance we removed from the base of the tongue a mass of solid tissue which microscopically proved to be normal thyroid. Years later, when the child showed signs of hypothyroidism we realized that we had removed the only thyroid tissue the child had.

Micrognathia or Pierre-Robbins syndrome presents a most difficult problem in the newborn infant. Not only can the child not breathe because the tongue, drawn back by the tiny mandible, closes the glottis but neither can the child feed well because of a cleft palate. Grasping the tongue and pulling it forward relieves dyspnoea but one cannot hold on to the tongue indefinitely. Some have advised putting a stitch in the tongue and holding it forward with a mechanical device : a logical idea but the suture promptly cuts through the soft tissue of a small tongue. We have treated

277

Fig. 1 (b)   Infant being held by nurse.

the routine cases by placing them prone on a Bradford frame to allow the tongue to drop forward and feeding them by gavage or with an in-dwelling plastic tube inserted into the stomach through the nostril. A plastic tube is far better tolerated than a rubber tube and can be left in safety for five to seven days without producing local necrosis. For the more severe cases in whom dyspnoea persists in spite of the prone position tracheotomy is necessary. These children require a tremendous amount of nursing care but in the course of a couple of months improve to the point where they can breathe comfortably and eat without choking. Eventually, the jaw grows, the tongue comes forward and they become acceptable members of society except for a so-called weak chin. The palate is closed at a suitable time later.

Cystic hygromas, or lymphangiomas, vary tremendously in size and extent and usually occur on the lateral surface of the neck in front of and below the ear. If respiration is undisturbed and feeding is possible

a suitable time for operation is chosen. In those cases in which the growth extends about the trachea and oesophagus and even into the thorax emergency measures are often necessary to relieve pressure. At operation we have upon two occasions been too energetic in pursuing extensions of the tumour around the vital structures of the neck ; in one instance a recurrent laryngeal nerve was injured with consequent difficulty in breathing ; in another superior laryngeal nerve injury was followed by difficulty in swallowing. It is now our policy to remove as many of the cysts as possible with safety, cut the tops from cysts which are in danger areas and follow surgery with roentgen therapy. Much difference of opinion exists about the efficacy of X-ray therapy. We give two doses of 400 roentgens a few days apart, wait a couple of months and then repeat the two doses. Results vary from marked to minimal improvement but are worthy of trial. Complete removal of a cystic hygroma about the neck is rarely possible nor necessary because these growths are not malignant and tendency to spread is minimal. If a good cosmetic result is obtained one may be content with less than complete removal.

The numerous problems of haemangiomas and polyps of the vocal cords, strictures, stridors, etc., are best handled by the endoscopist. Lesions arising in the chest demand prompt diagnosis and energetic treatment.

Pneumothorax in the newborn may be spontaneous or induced. Atelectatic lungs full of fluid suddenly begin to expand at the moment of birth. It is logical that too rapid expansion of one portion of the lung may lead to over-distension and that a sudden, lusty cry may cause rupture of an alveolus. Induced pneumothorax may be the result of too vigorous attempts at resuscitation. Blowing in the infant's mouth is still a common practice and, if too energetically applied, may lead to rupture of the lung. It is quite natural for the obstetrician to become alarmed when an infant does not breathe and is cyanotic, and in desperation to apply his own full lung pressure to the baby's mouth to induce adequate respiration.

Pneumothorax in the newborn may be confined to the mediastinum (Fig. 2). Air leaks through the alveoli and finds its way proximally along blood vessels to the mediastinum. Large blebs and collection of air behind the sternum may be sufficiently large to interfere with return of blood to the heart by the mechanism referred to as the " air block syndrome."

Roentgenograms will show air shadows about the heart and large vessels. What needs to be done is purely a matter of circumstance and judgment ; often no treatment is required. If respiration is impeded to the point that relief is necessary air may be aspirated by needle or a thoracotomy may be necessary for puncture of the offending cysts. Just what to do and how much to do at what moment is a matter of individualization for each patient.

Typical pneumothorax with collapse of a lung is more common than mediastinal emphysema and more easily handled. A good roentgenogram

279
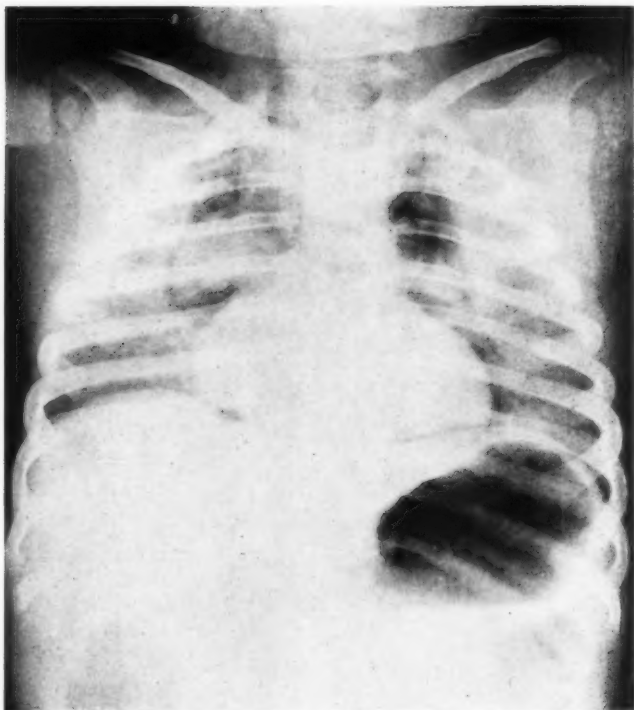
Fig. 2.   Mediastinal pneumothorax.

(Fig. 3) makes the diagnosis. Needle aspiration of air is life saving. The impulse to leave a needle in the chest and attach it to suction must be denied because the expanding lung may hit the needle point and be further injured. A small catheter introduced into the chest between the ribs and attached to gentle negative suction will re-expand the lung in a few days. Accidental puncture of the oesophagus with a catheter is a not too uncommon cause of pneumothorax and is easily diagnosed by observing fluoroscopically a bit of swallowed lipiodol entering the chest. A continuous stream of air flowing into the suction bottle for a number of days suggests a congenitally open bronchus. We overlooked this possibility in an infant and at post-mortem examination found just that—an open bronchus in the middle lobe which could so easily have been removed.

Congenital lung cysts in the newborn are of special interest because they are uncommon and yield so dramatically to surgical treatment. Not at birth but usually between the fifth and tenth day of life the infant develops increasing dyspnoea and eventually cyanosis.   Roentgenograms are
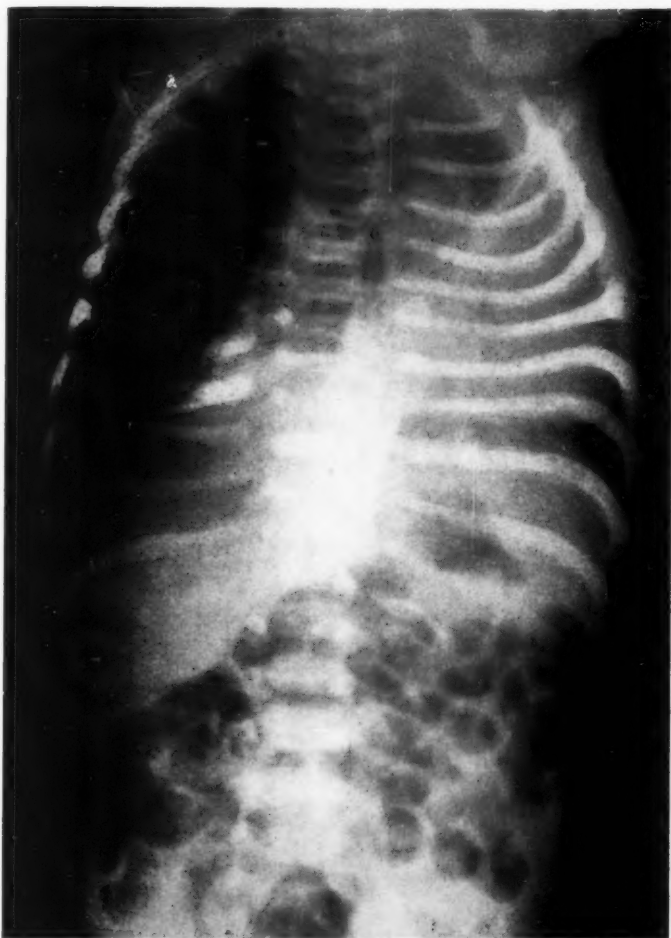
Fig. 3. Typical pneumothorax occurring immediately after birth.

diagnostic (Fig. 4). Having made a diagnosis of a progressively expanding lung cyst in an infant it is essential that a surgeon with a 50cc. syringe and needle in hand remains with the child while the operating room is being prepared for emergency surgery. If at any time dyspnoea becomes alarming the cyst must be aspirated. Repeated aspirations may be necessary as the child is being transported to surgery. Operative removal of the lobe or section of the lung from which the cyst arises is easily accomplished. Our experience with approximately ten such cases has been very

281
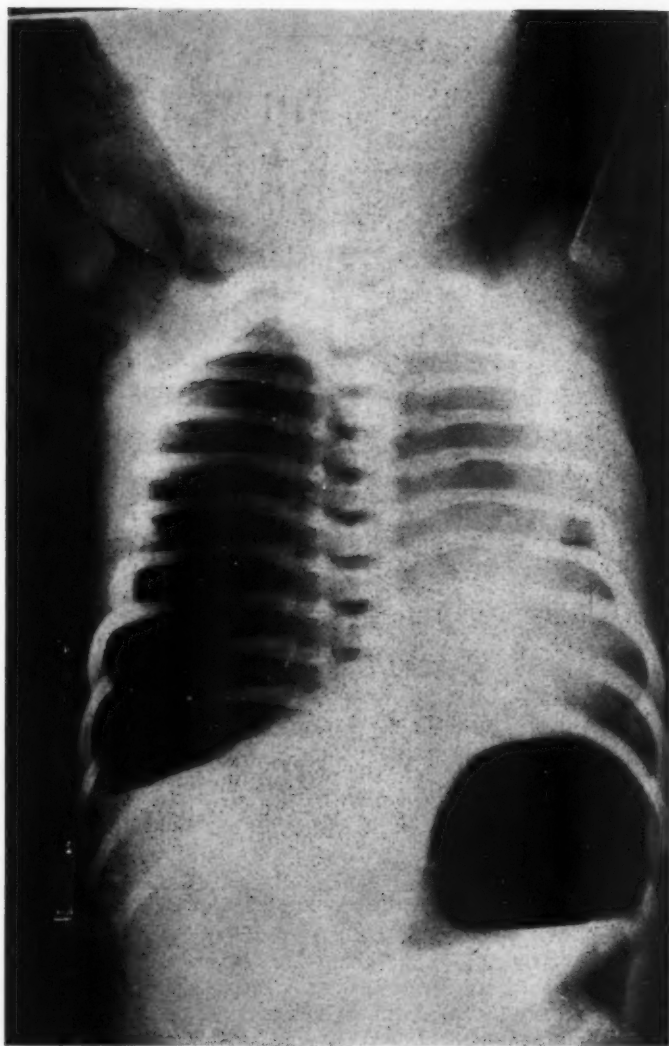
Figs. 4 (a). Anteroposterior roentgenogram of an expanding lung cyst in an eight-day-old infant.

Fig. 4 (b). Lateral roentgenogram of an expanding lung cyst in an eight-day-old infant.

283

happy because of good fortune in having the cyst in all instances confined to one lobe of the lung. Generalized cysts involving an entire lung leave one no choice but to remove such a lung recognizing that infants tolerate pneumonectomy very poorly.

Congenital lobar emphysema in many respects resembles lung cyst but is far slower in producing respiratory distress. Usually the upper lobe on either side is affected. Towards the end of the neonatal period dyspnoea appears but rarely becomes severe. The aetiology of lobar emphysema, not always specific, appears in most instances to be due to malformation of cartilaginous rings in the main stem bronchus. The weak-walled bronchus allows normal active inspiration but collapses during passive
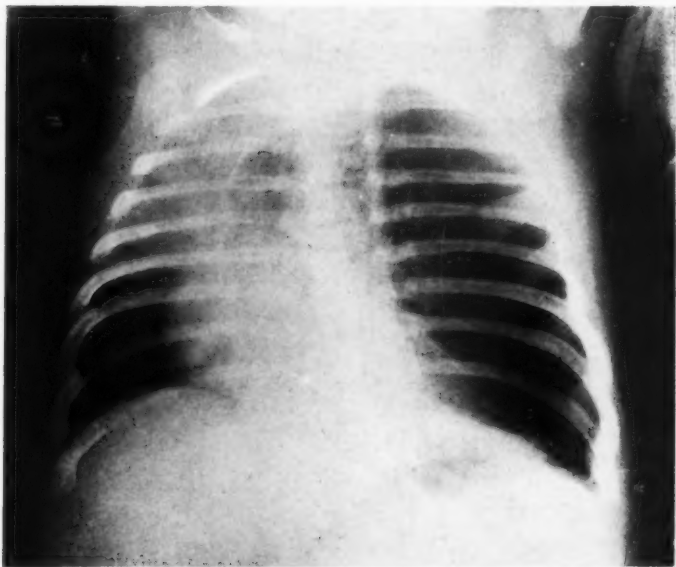
Fig. 5. Congenital lobar emphysema in a seventeen-day-old infant. Note the collapsed lower lobe.

expiration and thus by ball-valve action traps increasing amounts of air in the slowly distending lobe. Roentgenograms resemble those of lung cysts except for this very specific difference—the outline of the structure of the lung can be seen in the emphysematous lobe (Fig. 5).

Operation is rarely an emergency but eventually lobectomy becomes necessary. The lower lobe, compressed into a small mass no larger than the distal phalanx of one's thumb, in a week or more will have expanded to fill the entire chest cavity.

Congenital diaphragmatic hernia demands quick diagnosis and prompt treatment because of encroachment upon respiratory space by the bowels crowded into the chest. Again, roentgenograms make the diagnosis (Fig. 6). A true congenital diaphragmatic hernia, whether right or left,
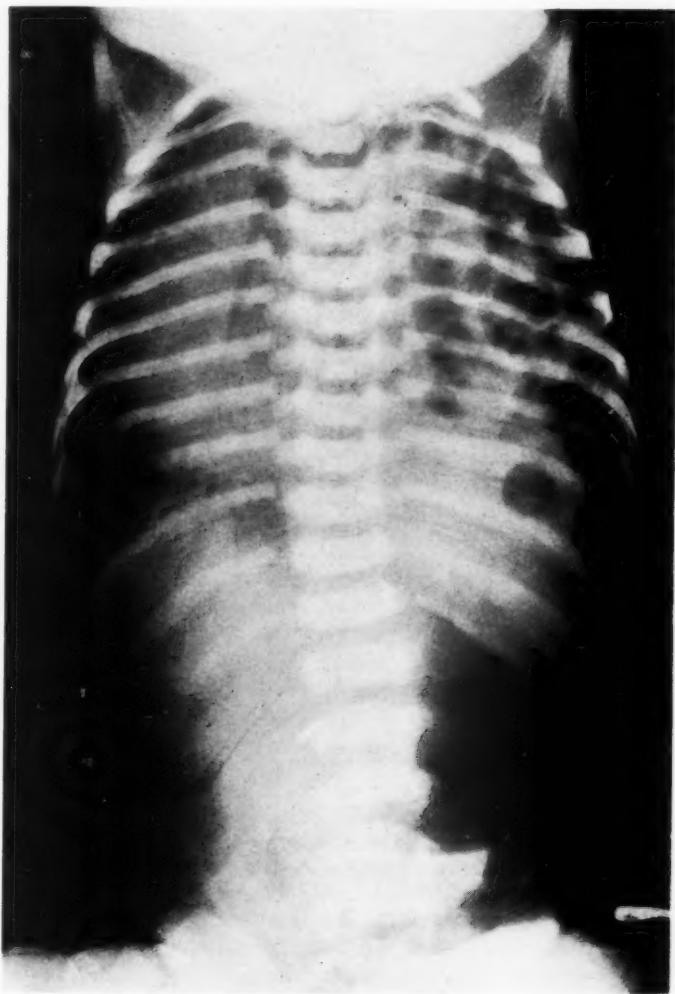
Fig. 6. Congenital diaphragmatic hernia in a newborn infant. All abdominal viscera except the liver and descending colon in the chest.

285

25—2

requires emergency surgery to relieve symptoms or to prevent symptoms. The infant who is only slightly dyspnoeic may in a few hours, as the bowels fill with air swallowed with feedings, become acutely dyspnoeic and die. We believe that these hernias should be approached by the abdominal route. The bowels can quickly be delivered and respiration prompt restored. The lung, having been compressed by the bowels during many months of foetal life, will be hypoplastic and will not expand as pressure is made on the anaesthetic bag. The surgeon must caution the inexperienced anaesthetist not to apply more than 10 centimetres of water pressure in attempts to expand the lung. Upon two occasions too vigorous pressure applied to the anaesthetic bag caused rupture of the contra-lateral lung.

The hernial orifice is closed with interrupted silk sutures and as the stitch is being tied air is withdrawn from the chest by catheter bowels are placed in the undeveloped abdominal cavity and the closed. Although air has been withdrawn from the chest as the dia was being closed, it is wise to aspirate the chest with a needle just before the child is removed from the operating table. This manoeuvre will draw the heart to its proper position, allow full expansion of the contralateral lung and aid expansion of the hypoplastic lung. In the course of a week or less the hypoplastic lung will have expanded sufficiently to fill the chest cavity.

Vascular rings or anomalies of the aortic arch vary in the degree in which they compress the trachea and oesophagus from no obstruction whatsoever to severe occlusion and suffocation. The infant who has laboured respiration with suprasternal and infrasternal retractions with each respiration, who constantly holds its head far backward, who feeds poorly and during feedings is apt to have attacks of cyanosis and syncope probably has an obstructing vascular ring. The older child, rarely in acute danger, may have inspiratory stridor and an odd cough which resembles the bark of a sea lion.

A swallow of lipiodol—rather than barium which may be aspirated and cause bronchitis—viewed in the lateral position fluoroscopically (Fig. 7) will show indentation in the posterior wall of the oesophagus often referred to as a " cooky bite." A good roentgenogram may also show narrowing of the trachea at the same point. If suitable fluoroscopic visualization of the deformity in the oesophagus is not possible following the swallowing of a drop of oil, injection of lipiodol—warmed to promote easy flowing—through a small catheter introduced through the mouth or a nostril into the upper end of the oesophagus will be helpful in clearly identifying the filling defect. At endoscopic examination one may see a vessel pulsating against the posterior wall of the oesophagus.

Many variations of anomalies of the aortic arch have been seen and all have been approached surgically by a left submammary incision through the third interspace cutting the second and third ribs at the costosternal junction for adequate exposure. The greatest hazard in the operation is

Fig. 7. Anomaly of the aortic arch in a sixteen-day-old infant causing compression of the oesophagus and trachea.

that of anaesthesia. The site of tracheal compression is just above the carina and it is often difficult to pass a tube beyond the point of tracheal compression without going into one bronchus or the other.

Following operation breathing is apt to be laboured because of trauma to the constricted trachea. All these children are placed in high humidity and oxygen after operation and observed carefully for respiratory distress. Tracheal and laryngeal oedema are the most distressing post-operative complications, occasionally requiring tracheotomy. In one instance a polyethylene tube was introduced through the nose, through the site of

287

inflammatory obstruction in the trachea and into the right bronchus a d actually left there for eight days. It did not seem possible that a tube n the bronchus could be tolerated for such a prolonged period but there was no alternative; each earlier removal was immediately followed by recurrence of severe dyspnoea requiring its replacement. The child survived.

Atresia of the oesophagus with tracheo-oesophageal fistula is undoubtedly the most common surgical emergency of infancy and is associated with numerous and severe respiratory problems. A few points only can be made about this subject which well might occupy our entire time this afternoon.

The infant who has difficulty in breathing immediately after birth; whose nose and throat are filled with excessive mucus; who after removal to the nursery continues to have thick saliva in its mouth and bubbles about the lips probably has atresia of the oesophagus. Inability to pass a catheter into the stomach supports the presumptive diagnosis; injection of 1cc. of lipiodol with a catheter into the oesophagus and roentgenographic demonstration of a blind pouch clinches the diagnosis.

Pneumonia and atelectasis are usually present at the time the diagnosis is made—unfortunately usually between the second and fourth day of life. During the few hours before operation the pharynx is aspirated every fifteen minutes and the infant is stimulated to cry in order to loosen and eliminate some of the viscid secretions in the trachea-bronchial tree.

The operation is performed transpleurally under endotracheal anaesthesia. Not infrequently a bit of pressure on the involved lung— usually the right upper lobe—will express some secretions and allow later expansion of the lung.

After operation careful aspiration of the pharynx with a marked catheter to avoid injuring the anastomosis is continued as necessary.

Post-operative mortality has been lowered approximately 20 per cent. by careful feeding. On the fourth or fifth day after operation a swallow of lipiodol is given and the oesophagus observed roentgenographically for patency and leakage. If all is well feeding is begun *with a medicine dropper*. By this method one can be assured of avoiding too rapid feeding, filling of the dilated upper end of the oesophagus, regurgitation and aspiration of formula with consequent suffocation. The medicine glass is placed on the table, the nurse, holding the baby on her lap, reaches for a medicine dropper full of formula—about 1/2cc.—and gives it to the child. While the nurse again reaches for a refill the small quantity of feeding has trickled through the oesophagus. A suction machine with catheter attached is placed close by. At the slightest sign of regurgitation or choking the nurse flips the switch on the suction machine and aspirates the throat. This method of post-operative feeding is slow but rewarding in avoidance of respiratory obstruction.

Tracheo-bronchial obstruction is the most common cause of death following major surgery in newborn infants. The infant, weakened by disease and surgery, is unable to cough up obstructive particles of food, mucus, blood or vomitus. Too weak to cry it feebly stops breathing and dies.

Before the child leaves the operating table it is imperative, especially in infants who have had anaesthesia administered by intubation, that

Fig. 8. Mobile emergency cabinet containing all equipment necessary for resuscitation following operation. Tracheotomy sets are in lower drawer.

289

proper tracheal clearing be performed by careful aspiration. Beware of traumatic and too persistent aspiration which may cause bleeding and double the hazard of obstruction. In the recovery room the infant is placed in the crib or isolette on his side, never on his back ; a couple of small sand bags will hold him in the desired position. The slightest difficulty in breathing or the appearance of cyanosis is promptly reported to an anaesthesiologist or surgical resident who is near by. The nurse constantly has ready a laryngoscope, intratracheal tubes, aspirating catheters, breathing masks, suction apparatus and oxygen. Removal of a tiny mass of obstructing material in the trachea will often restore normal breathing.

Beside wall oxygen and suction we have in the recovery room a portable cabinet containing all the equipment necessary for resuscitation (Fig. 8). The recovery room closes at 5 p.m. each day, at which time all infants who have had major surgery and all older children who have had heart or chest surgery are moved to four bed wards on the same floor as the recovery room. We call these wards, our second recovery rooms. In these wards the patients are attended by nurses skilled in recognizing early signs of respiratory obstruction. During the night the portable cabinet mentioned above is moved to the patient area where it is kept ready for use. A daily check on the equipment in the cabinet is mandatory.

As soon as the patients are out of danger they may be moved to other floors and private rooms as parents desire. Even then the danger of sudden vomiting and aspiration has not passed. To meet this problem
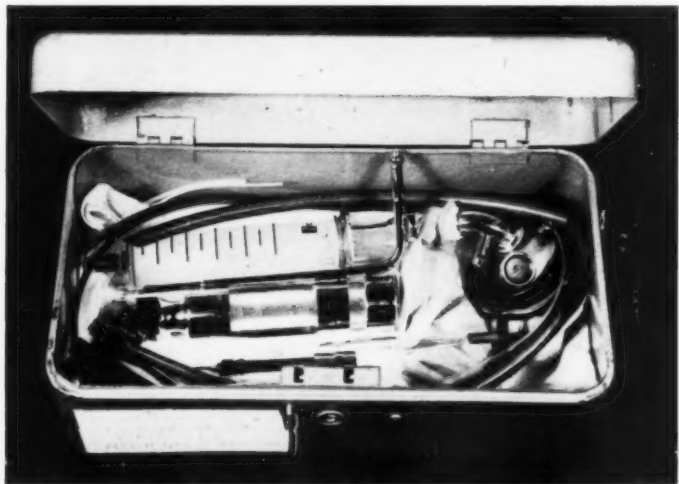
Fig. 9. Such an emergency kit in an ordinary fishing box is kept on each floor. See text.

which may arise in any severely ill infant, medical or surgical, an emergency kit containing laryngoscope, small intratracheal tubes, syringe, catheters and fine plastic tubes is available for instant use. Again, it is the duty of the head nurse on each floor to check daily the equipment in this emergency box (Fig. 9). The effort which has gone into providing proper equipment for the care of respiratory emergencies and education of the house staff in skilfully using this equipment has paid dividends in saving many children from aspiration and fatal suffocation.

SUMMARY

At the moment of birth each infant suddenly meets the necessity of utilizing his own respiratory system. Obstruction in the tracheo-bronchial tree or diminished ventilatory space call for swift and sure action.

A few of the more common conditions interfering with adequate respiratory exchange are briefly reviewed.

Aspiration is the most common cause of death following major surgery in infants. Methods used to combat this problem are described.

DONATIONS

THE FOLLOWING generous donations have been received during the last few weeks :

Appeal Fund:

£1,000 p.a. for 7 years under covenant.   F. W. Woolworth & Co. Ltd.

£100   Esso Petroleum Co. Ltd.

The Library and Coulthurst Room:

£1,000   R. R. James, F.R.C.S.

£105   Coulthurst Trust (further gift)

Department of Anaesthetics:

£2,500   Glaxo Charity Trust

Department of Dental Science:

£100   Coventry Newspapers Ltd. (further gift)

HAND SURGERY

THE HAND CLUB of Great Britain and The Second Hand Club are holding an open meeting at the Royal College of Surgeons on Saturday, November 22, from 10 a.m. to 4 p.m. with lunch at the College.

Any surgeon interested in Hand Surgery is invited to attend. Further particulars may be obtained from the Hon. Secretary, The Second Hand Club, H. Graham Stack, 150, Harley Street, W.1.

THE SURGICAL ASPECTS OF ADRENOCORTICAL
DISORDER

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TWO HUNDRED YEARS ago John Hunter was obliged to list the adrenal glands under the heading " of parts whose uses are not known " (Hunter, 1861). One hundred years ago Thomas Addison had just published his monograph on " The constitutional and local aspects of disease of the supra-renal capsules " and Brown-Séquard had found that the adrenals were essential to life (Rolleston, 1936). To-day we know a great deal more about these complex organs, but our knowledge is still far from complete. I shall confine myself to the adrenal cortex and to the syndromes which are associated with excessive or with diminished secretion of its hormones. Several colleagues in Belfast have collaborated with me in the work which I shall describe and Dr. D. A. D. Montgomery has been closely associated with all of it.

Physiology

The physiology of the adrenal cortex is closely related to that of the anterior lobe of the pituitary and the two glands are sometimes referred to as the pituitary-adrenal axis. Three main groups of steroid hormones are secreted :

(1) The glucocorticoids are essential to life and influence profoundly many metabolic processes. Hydrocortisone is the main member of this group. Cortisone has similar properties, but is not itself the physiologically active hormone.

(2) The electrocorticoids (or mineralocorticoids) are also important and control the metabolism of electrolytes and water. Aldosterone is the principal hormone.

(3) The sex hormones are of two types—male (androgens) and female (oestrogens and progesterones). These have little physiological importance but are active in certain pathological states.

The secretion of hydrocortisone is mainly under the control of corticotrophin (ACTH). This is formed in the anterior lobe of the pituitary, which in turn comes under the influence of the hypothalamus. The effective stimuli for its production include various forms of stress, including that of a surgical operation. There is, further, a reciprocal relationship between the secretion of ACTH and that of hydrocortisone whereby the production

of ACTH is inhibited when an adequate or excessive amount of hydro-cortisone is circulating in the blood (Fig. 1). Thus, in normal conditions, the secretion of hydrocortisone is finely adjusted to the body's needs. The androgens of the adrenal cortex are also under the control of ACTH and are best regarded as a by-product of hydrocortisone secretion. They do not inhibit the formation of ACTH, so that hydrocortisone acts as a

ACTH
STIMULATES

HC
INHIBITS

HC AND.
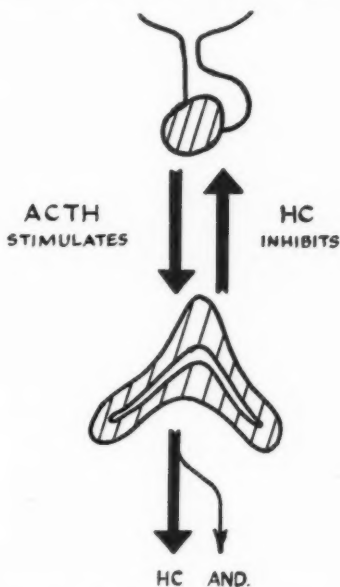
Fig. 1.   Reciprocal control of production of Corticotrophin (ACTH) by the pituitary and Hydrocortisone (HC) by the adrenal.   The Androgens (AND) are a by-product of hydrocortisone.

regulator for both glucocorticoids and androgens.   They *do*, however, inhibit the formation of gonadotrophins by the pituitary.   We shall see the importance of this when we discuss the adrenogenital syndrome.

Adrenocortical hyperfunction

Let us deal first with adrenocortical hyp*er*function—that is with the lesions and syndromes associated with excessive production of adrenal steroids.   The adrenal *lesions* are hyperplasia, adenoma and carcinoma. Hyperplastic glands are under control of ACTH, while carcinomata secrete autonomously.   Adenomata are intermediate and are usually under partial ACTH control.   The syndromes which are produced by these lesions vary according to the particular group of steroids whose secretion is increased.   The syndromes are as follows :

293

Glucocorticoid or hydrocortisone excess causes *Cushing's Syndrome;*

Androgen excess causes virilism, that is the adrenogenital syndrome and some features of Cushing's Syndrome.

Electrocorticoid or aldosterone excess causes *aldosteronism* (Conn's Syndrome) ; and

Oestrogen excess causes *feminization.*

I shall not mention the last two again because, although they are interesting, they are very rare and we have not seen examples of them (Welbourn, 1957a).

Cushing's Syndrome

This is a rather uncommon condition described by Harvey Cushing twenty-six years ago (Cushing, 1932). It is caused in most cases by excessive secretion of glucocorticoids by the adrenal cortex, and an identical clinical state can be produced by prolonged administration of cortisone or ACTH. The lesions which may cause it can be classified as follows :

(1) In the adrenals themselves there may be hyperplasia or hyperfunction of structurally normal glands. These conditions may be primary or secondary to lesions in the pituitary. Tumours (adenoma or carcinoma) are sometimes found and are clearly primary lesions.

(2) In the pituitary there may be a benign basophil adenoma. This tumour is nearly always small and is sometimes found post mortem in otherwise normal subjects. Cushing believed it to be the essential lesion in the majority of patients with the Syndrome, but recent surveys show that it is present in only about half (Thompson and Eisenhardt, 1943). When it is present the term " Cushing's *Disease* " is appropriate. Very rarely a malignant basophil carcinoma is present.

An almost constant finding in the non-tumourous part of the pituitary is hyalinization of the basophil cells (Crooke, 1935), which is probably the result rather than the cause of the excessive secretion of glucocorticoids by the adrenals.

(3) Other lesions which are rarely associated with the syndrome are disorders of the hypothalamus, which presumably stimulate the pituitary ; ovarian tumours, which sometimes contain adrenal-like cells ; certain forms of liver disease ; and carcinoma of the bronchus, thymus or pancreas. The mechanism in these cases is unknown.

Our series includes nineteen patients whom we have seen in the past five years. The findings in the adrenals were as follows :

Hyperplastic or hyperfunctioning	15
Adenoma	1
Carcinoma	1
Unknown (hypophysectomy—1 awaiting operation—1)	2

The average combined weight of the adrenals in the non-tumourous glands was 15.8gms., that is about one third greater than normal. One of these patients had a carcinoma of the bronchus (Harrison, *et al.*, 1957).

294

The pituitary has been examined in five cases with the following findings :

Basophil adenoma   2
Basophil carcinoma   1
No tumour   ∴   2

The syndrome is commoner in the female than in the male and this series includes fourteen women and five men. It may appear at any time and in our patients the age of onset ranged from eleven to sixty-eight years, with an average of thirty-seven. The main clinical features are a characteristic form of obesity, which involves the face (Fig. 2) and trunk but spares the limbs, a florid complexion, striae on the abdomen, arterial hypertension and sometimes diabetes. Some degree of virilization is common and is probably caused by excessive secretion of androgens as well as of glucocorticoids. It causes hirsutism, acne and amenorrhoea.

Fig. 2.   Cushing's Syndrome in a woman of forty-three. (a) Before operation.
(b) Eighteen months after sub-total adrenalectomy.

There are often other features, which may bring the patient to the surgeon rather than to the physician :

(1) Osteoporosis is common.   It causes spinal deformities and pathological fractures, especially of the ribs and vertebrae. Half our patients had osteoporosis and three had spontaneous fractures of the spine.

(2) Osteoporosis also leads to excessive excretion of calcium in the urine, and this may cause urinary calculi. One of our patients has had two attacks of ureteric colic, but we have not been able to demonstrate a stone.

(3) Inflammatory lesions are common. In our series one patient had septicaemia, another pulmonary tuberculosis and a third a superficial abscess.

295

(4) Gastric secretion is frequently increased (Kyle, *et al.*, 1956) and may cause duodenal ulceration. Ulcer dyspepsia was the presenting feature in two of our patients.

The prognosis of the untreated case is bad, and half the patients die within five years of the onset of the disease, from the effects of hypertension, infections and diabetes.

The adreno-genital syndrome

In this syndrome, which was first described adequately by Bullock and Sequeira (1905), androgens are secreted in excess by the adrenals and cause virilism in women and girls and precocious development of the secondary sex characteristics in boys.

The adrenal may be the site of a tumour or of hyperplasia (Fig. 3). A tumour secretes large amounts of androgens, while the secretion of

VIRILIZING ADRENAL LESIONS
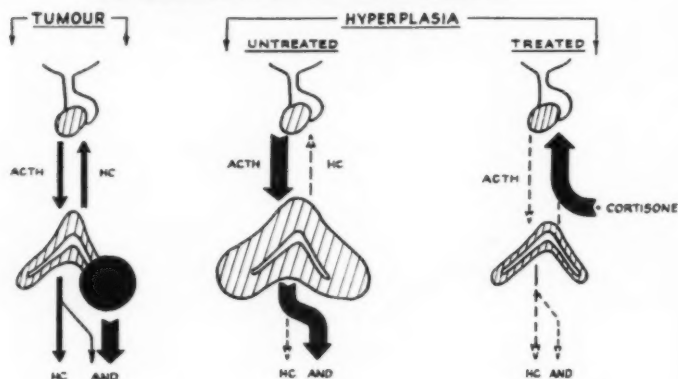
Fig. 3. Diagrams illustrating the hormonal relationships described in the text. Abbreviations as in Fig. 1.

hydrocortisone by the healthy gland remains normal. In virilizing hyperplasia the essential lesion is a biochemical one which causes the adrenals to form androgens instead of glucocorticoids (Bongiovanni, *et al.*, 1954). Hydrocortisone, as we have seen, normally acts as a brake on the production of ACTH, and, in its absence, the adrenal is driven to secrete large amounts of androgens and to enlarge in the process.

The effects of androgens on the tissues vary with the age and sex of the patient and hence different varieties of the adrenogenital syndrome are encountered (Table I).

TABLE I

VARIETIES OF ADRENOGENITAL SYNDROME

	FOETUS	CHILD	ADULT
LESION	Hyperplasia	Tumour	Hyperplasia or tumour
MALE SYNDROME ..	Macrogenitosomia praecox ("Infant Hercules")		Excessive virilism
FEMALE SYNDROME ..	Female pseudo-hermaphroditism	Virilism	

(1) One type arises in foetal life. The adrenal lesion is always hyperplasia. In the female (pseudo-hermaphroditism), if the disorder starts early enough, the urogenital sinus fails to differentiate into its two parts. The sinus persists at birth and forms a common opening for the urethra and vagina. The clitoris enlarges also. If the adrenal disorder arises later, when the sinus has already divided, the large clitoris is the only abnormality seen at birth. The condition is often familial. Girls suffering from it may be mistaken for boys with undescended testicles and severe hypospadias. The diagnosis may be made by several tests :

(i) Microscopy of the cell nuclei shows that the chromosomal sex is female.

(ii) Inspection of the urogenital sinus with a urethroscope shows the vaginal orifice opening into its posterior wall and may allow the uterine cervix to be seen and catheterized. Radio-opaque material, injected through the catheter, demonstrates the uterus and tubes.

(iii) Biochemical tests (see later) reveal an abnormal excretion of androgens. Biopsy of the gonads is no longer necessary for diagnosis.

A similar condition may affect the male foetus (macrogenitosomia praecox or " Infant Hercules "). No abnormality is seen at birth, but within a few weeks the penis starts to enlarge.

(2) In childhood a congenital virilizing lesion may continue to exert its influence or a new lesion (usually a tumour) may develop. The androgens cause " pre-pubertal virilism " in the female and macrogenitosomia praecox or " Infant Hercules " in the male. In both sexes the epiphyses appear very early and the bones grow excessively so that, as children, these patients are very tall for their years. The epiphyses, however, fuse early also and the final adult height is usually less than 5 feet. The secondary sex characters also develop precociously. In girls there is primary amenorrhoea and sex characters of the male type develop early. In boys the testes remain small because the adrenal androgens inhibit the production of gonadotrophins by the pituitary. This sign helps to distinguish patients with lesions in the adrenal from those with disorders of the pituitary or central nervous system, in whom the testicles develop precociously.

297

(3) In the adult a lesion which was present in childhood may remain active, or a new one (either hyperplasia or tumour) may develop and cause post-pubertal virilism. The clinical features, which are similar to those which are sometimes seen during testosterone therapy, vary in their severity and none of them is constant. They are of three types :

(i) Direct virilization of the tissues. This includes hirsutism of the male type (Fig. 4), growth of the larynx which causes deepening of the
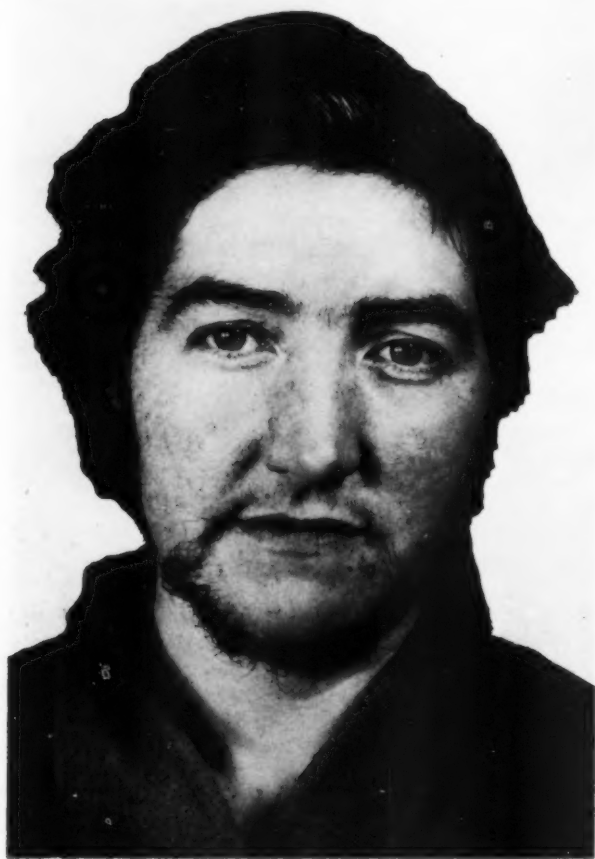
Fig. 4. Post-pubertal virilism in a woman of thirty-three.

voice, a masculine type of muscular development and enlargement of the clitoris or penis.

298

(ii) Defeminization, which is the result of the inhibition of gonadotrophins. This causes amenorrhoea, sterility, atrophy of the breasts, loss of sub-cutaneous fat, and atrophy of the external genitalia, except the clitoris.

(iii) Non-specific actions include a general synthesis of protein with increase in body weight. Acne is very common and there is sometimes retention of salt and fluid which causes hypertension.

A similar state occasionally develops in the male, but usually passes unnoticed.

Our own series of seven cases includes the following :

     Female pseudo-hermaphroditism :

Infants	1
Adults (sisters)	2
Post-pubertal virilism	4

Six of these patients have hyperplastic glands and one had a carcinoma.

Diagnosis

The diagnosis of these adrenal disorders is not easy. Cushing's Syndrome must be distinguished from other types of obesity, hypertension and diabetes and the adrenogenital syndrome from other varieties of inter-sex, precocious development and virilism. Ovarian lesions, for instance, may cause very similar clinical states. We see many patients who do not conform to any of the syndromes which I have described and in whom we are not able to make a firm diagnosis. The problem is further complicated by the fact that Cushing's and the adrenogenital syndromes have many features in common and are not always easily distinguishable.

A full investigation is elaborate, time-consuming and often inconclusive ; but without it accurate diagnosis and rational treatment are impossible. The first problem is to decide which patients to investigate fully. Generally speaking investigation is required when there are serious clinical grounds for suspecting an adrenal disorder, and when treatment seems desirable. It is certainly needed if there is likelihood of a tumour being present ; and a tumour should be suspected if symptoms appear during childhood or if they develop rapidly in an adult. There are four main questions to be answered :

(1) Is there an adrenal disorder ?

(2) If so, is it hyperplasia or a tumour ?

(3) If a tumour, which side is it ?

(4) Is there an underlying lesion in the pituitary or C.N.S. ?

Three types of special investigation are used routinely :

(1) *Biochemistry*—The main test is the measurement of the urinary steroids. We measure routinely the glucocorticoids (i.e., hydrocortisone and similar substances) and the androgens (or 17-ketosteroids) (Table II).

299

TABLE II

URINARY STEROIDS IN HYPERFUNCTIONING LESIONS OF ADRENAL CORTEX
(The excretion may be normal (=), increased (+), greatly increased (+ +) or reduced (−))

	Benign Lesions		Carcinoma
	Cushing's Syndrome	Adreno-Genital Syndrome	Either Syndrome
GLUCOCORTICOIDS (Hydrocortisone, etc.)	+	= or −	+ +
ANDROGENS (17-Ketosteroids)	= or +	+	+ +
Effect on steroid excretion of ACTH / Cortisone	+ / −		Nil / Nil
Excess of specific steroids	Nil	Pregnane-triol	De-hydroiso-andro-sterone (D.H.A.)

These tests are helpful, but they are not sufficiently reliable to be diagnostic, and they must only be used to supplement clinical and other methods of examination (Montgomery and Welbourn, 1957). Characteristically, in those with benign lesions, the excretion of gluco-corticoids is high in Cushing's Syndrome and normal or low in the adrenogenital syndrome. That of androgens is high in the adrenogenital syndrome and normal or slightly raised in Cushing's Syndrome. In carcinoma, whatever the syndrome, the excretion of both tends to be very high. The injection of ACTH, in those with benign lesions, increases the excretion and exaggerates the difference between normal and diseased subjects. In carcinoma ACTH has no effect. Conversely, the administration of cortisone or its analogues, which inhibit the production of ACTH, depresses the excretion of steroids in benign lesions but not in malignant ones. Finally, in the adrenogenital syndrome, tests for specific steroids in the urine may help to distinguish benign from malignant lesions. Those with virilizing hyperplasia, especially of the congenital type, often excrete an excess of pregnanetriol, and those with carcinoma an excess of dehydro-isoandrosterone.

(2) **Radiography.**—The special X-rays include, first, a view of the pituitary fossa (Fig. 5). Usually it is normal. Two of our patients with osteoporosis had fossae which *appeared* big. After adrenalectomy, when the bones had re-calcified, the fossae became normal. One patient had definite enlargement of the fossa. Her visual fields were normal, but the presence of an adenoma was confirmed after hypophysectomy. The fossa in the patient with a basophil carcinoma was normal at first but enlarged three years after adrenalectomy.

The best method of X-raying the adrenals is to introduce about a litre of carbon dioxide in front of the sacrum (Landes and Ransom, 1957).

<center>(a)   (b)   (c)</center>
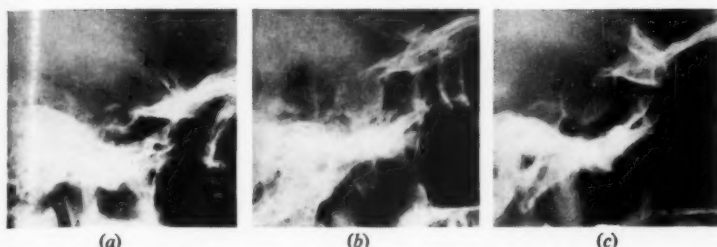
Fig. 5. X-rays of the pituitary fossa in Cushing's Syndrome. (a) Normal. (b) Apparent enlargement due to osteoporosis. (c) Real enlargement due to basophil adenoma.

Other gases, such as air and oxygen, give better pictures but, being less soluble, are dangerous and may cause death from gas embolism. The gas passes up behind the peritoneum and outlines the kidneys and adrenals. If an I.V.P. is done at the same time and tomograms are taken the adrenals can usually be seen clearly. Unfortunately, we sometimes see tumours which aren't there or miss small ones that are, and the method is of most value in revealing large masses (Montgomery and Welbourn, 1957).

(3) **Surgical Exploration.**—If a tumour cannot be excluded after full investigation the adrenals must be explored surgically.

Treatment of Cushing's Syndrome

The object of treatment is to prevent the production of excessive amounts of glucocorticoids by the adrenals (Montgomery and Welbourn, 1957). If there is an adrenal tumour it must be removed. If the glands are hyperplastic or over-active an attack may be made either on the pituitary, by X-rays or surgery, or on the adrenals. Except in the rare cases in which a pituitary tumour is demonstrated, we believe that adrenalectomy is the better procedure. It will cure the syndrome whether the primary lesion is in the pituitary or in the adrenal. Hypophysectomy will not do so if the cause is an adrenal tumour, and a tumour cannot be excluded for certain without surgical exploration. The only point at issue is whether the adrenalectomy should be sub-total or complete. We have followed the practice of Priestley and his colleagues (Sprague, et al., 1953) at the Mayo Clinic and have found sub-total adrenalectomy to be both safe and effective.

The operations which were performed in our nineteen cases were as follows :   *Adrenalectomy:*

Removal of tumour	2
Adenoma 1	
Carcinoma 1	
Sub-total (nine-tenths of one gland and all	
of other)	14
Awaiting operation	1
Hypophysectomy (Mr. C. A. Gleadhill) ..	1
Nil (carcinoma of bronchus)	1

<center>301</center>

The great obesity in Cushing's Syndrome demands the best possible surgical access to the adrenals. We always approach them by the thoraco-abdominal route with the patient on her side and the table well broken. The operation of exploration and bilateral adrenalectomy is done in two stages with an interval of two to three weeks between the two sides. We prefer to explore the *left* gland first, since it is the more accessible and the easier to resect sub-totally. We use Fey's incision: that is we resect the eleventh rib extra-pleurally and define the adrenal at the upper pole of the kidney. It is easily recognized by its orange colour, which is quite different from that of the surrounding fat. When the gland has been exposed three courses are possible :

(1) If the gland is normal or hyperplastic it is resected sub-totally and the whole of the other gland is removed later.

(2) If a tumour is found, it is removed. A remission is likely to follow and the other gland need not be removed.

(3) If the gland is atrophied, it is probable (but not certain) that there is a tumour on the opposite side whose secretion is suppressing the production of corticotrophin. A biopsy is taken and the other gland explored later.

The sub-total resection of the left gland is done by clearing the lateral and anterior aspects of the gland without disturbing it posteriorly or injuring the small vessels which enter its periphery. A small corner (not more than one-tenth of the whole) is selected to be left in the body. The upper pole is usually suitable and is severed from the main portion of the gland with scissors. If it is viable its colour remains unchanged and blood oozes from its cut surface. If it turns blue the process is repeated with another corner. The remainder of the gland is then removed and the vein, which usually passes down from its medial aspect to the renal vein, is ligated and divided. We examined the small portions of gland that remained in three patients who died some time after operation. One weighed half a gramme and the second 1.3 gramme ; the third was almost entirely necrotic.

The right gland is placed more deeply than the left ; it lies behind the liver and close to the inferior vena cava. It sometimes extends behind the vena cava and may be adherent to it. It is best approached transpleurally through the bed of the tenth rib. The diaphragm is incised in the direction of the skin incision and the gland is defined, again at the upper pole of the kidney. It is cleared of fat anteriorly and the adrenal vein, which enters the vena cava directly, is seen clearly, ligated and divided. Unless this is done early in the operation there may be serious bleeding. The gland is then removed completely.

Two general points must be made about both operations :

(1) The glands are friable and it is wise to remove them with a thin covering of fat to avoid spilling cells which may later regenerate.
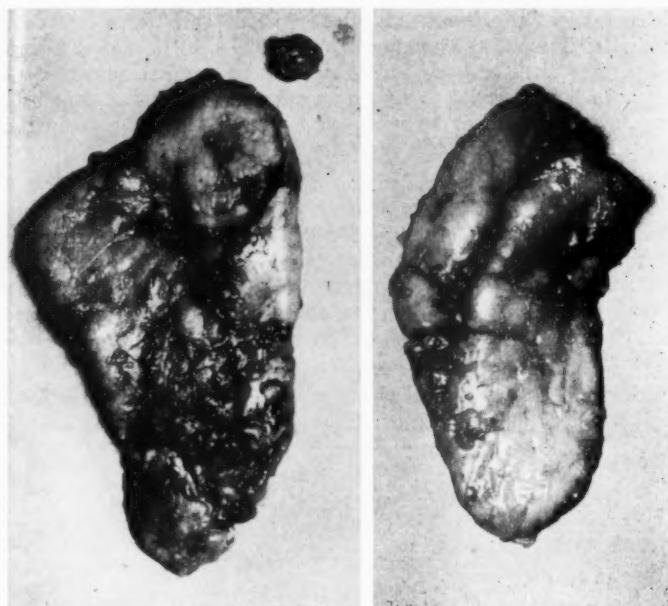
Fig. 6. The excised adrenal glands in Cushing's Syndrome seen from the front.
(a) Right gland. Wt. 10.1 gm. Note ectopic nodule. (b) Left gland. Wt. of excised
portion 8.3 gm. The upper corner (5-10 per cent. of the whole) has been left in the
body.

(2) There are sometimes outlying fragments of cortex near the glands.
They should always be sought and removed (Fig. 6).

Bilateral adrenalectomy was almost invariably fatal before the intro-
duction of cortisone, and it is essential to give substitution therapy over
the period of the operation. It is needed for the first operation as well as

TABLE III

DOSAGE OF CORTISONE AND DEOXYCORTONE ACETATE BEFORE AND AFTER ADRENALECTOMY

Day	Cortisone acetate	Deoxycortone acetate
2 days before operation	50 mg. 6-hourly, i.m.	
1 day before operation	50 mg. 6-hourly, i.m.	
Day of operation	100 mg. 3 hours before operation, by mouth	10 mg. 3 hours before and 5 mg. 6 hours after operation, i.m.
	25 mg. 6-hourly, i.m.	
1 day after operation	25 mg. 6-hourly, by mouth if possible, otherwise i.m.	5 mg. 12-hourly, i.m.
2-5 days after operation	25 mg. 6-hourly, by mouth if possible, otherwise i.m.	5 mg. i.m.
6-10 days after operation	12.5 mg. 6-hourly, by mouth	
11+ days after operation	12.5 mg. b.d., by mouth	

303

the second. We give cortisone in large doses for two days before and in decreasing doses afterwards; and deoxycortone acetate for a few days (Table III). Despite this treatment an adrenal crisis is not uncommon and hydrocortisone and nor-adrenaline may be required urgently. For this reason it is essential to set up an efficient intravenous drip before operation and to measure the patient's pulse rate and blood pressure every fifteen minutes for at least two days afterwards.

Cortisone is withdrawn gradually and can often be stopped after a few weeks or months following sub-total adrenalectomy. The dosage is determined by the absence of signs of adrenal failure when trial reductions are made. When the glands have been totally removed, cortisone must be continued indefinitely. After the removal of a functioning tumour ACTH is given as well for two weeks to stimulate the atrophied gland on the opposite side.

The immediate post-operative period may cause anxiety, but with proper care the operative mortality is low. We encountered the following complications in sixteen patients who underwent thirty operations.

Death (cause not discovered)		..	..	1
Adrenal failure:				
Acute: Adrenal crisis	..	..	..	5
Salt deficiency	..	..	..	1
Sub-acute	..	..	..	8
Miscellaneous:				
Wound infection ..	..	..	..	5
Chest complications	..	..	..	6
Psychosis (temporary)	..	..	..	1
Tachycardia	..	..	..	1

The late results of surgical treatment have been encouraging on the whole, but we have had many surprises and disappointments. The more experienced we become, the more cautious we grow about prognosticating.

The late results of adrenalectomy are as follows:

Late deaths (after partial or complete remission)	5
Cardiac failure 2	
Recurrence of adrenal carcinoma .. 1	
Bleeding pituitary carcinoma, three years after adrenalectomy 1	
Thrombosis of basilar artery two months after operation in boy of thirteen 1	
Remission (complete and lasting 10 months to five years)	10
Recurrence of syndrome:	
Adrenal carcinoma	1
Benign lesions	0

304

The patient who underwent hypophysectomy had her operation too recently for its effect to be assessed.

The remissions have been striking. The appearance and weight start to return towards normal within a few weeks and the process is complete in about six months (Fig. 2). The skin starts to peel and fine scales remain on the face until the remission is complete. Strength and energy return and the body regains its normal shape. The hair becomes lighter and softer and sexual function is restored. Hair on the face and trunk may diminish, but rarely disappears completely. The bones become re-calcified rather slowly, but eventually the spinal deformities become stabilized. The blood pressure falls significantly in all, but returns to normal in only a few. Irreversible cardiovascular changes, which were present before operation, continue to endanger life and the ultimate prognosis following surgery is not known.

The main problem in the long term management of our patients concerns the late post-operative adrenal function. It has not been, as we had anticipated, the recurrence of the Cushing's Syndrome, but rather the development of adrenal insufficiency. We have ten patients who have survived more than one year. Five (i.e., half) require no cortisone. One has never been able to stop taking cortisone and still requires 50mg. per day. Four, after stopping it for a time, have had to re-start it. Measurement of the urinary steroid excretion in those who have undergone sub-total adrenalectomy shows a low basal excretion and little or no response to ACTH. The patient who had an adenoma and who still has one intact adrenal gland, is the only one whose excretion is normal. The patient with a carcinoma had normal excretion for a time after operation. When the tumour recurred the excretion rose again. I shall discuss the implications of these findings later.

Treatment of the adrenogenital syndrome

The treatment of the adrenogenital syndrome concerns the surgeon less often than that of Cushing's Syndrome. An adrenal tumour is, in the opinion of most people, the only indication for adrenalectomy in this condition. Virilizing hyperplasia, which was formerly treated by adrenalectomy, can be managed satisfactorily by the administration of cortisone (Fig. 3), which inhibits the formation of ACTH (and hence of androgens) and supplies the glucocorticoid which is deficient (Wilkins, et al., 1955). We have five patients undergoing this form of therapy. A tumour should be removed, if possible, by the thoraco-abdominal route. In our single case the very large carcinoma was invading the liver and kidney and could not be removed. The patient died soon afterwards from pulmonary metastases.

The results of treatment of the adrenogenital syndrome by removal of a tumour or by cortisone are satisfactory in some respects, but leave much to be desired in others. If children are treated early, growth and

development become entirely normal. In adults normal sexual function returns, but hirsuties and deepening of the voice tend to persist.

Female pseudo-hermaphrodites require plastic surgery to correct the abnormalities of their genitalia. When they are a few years old—and certainly before puberty—the enlarged clitoris must be amputated and a vagina constructed.

Adrenal insufficiency

We will now leave adrenal hyperfunction and consider adrenal insufficiency (Welbourn, 1957b). This problem confronts surgeons more frequently than many of us realize. It is not confined to patients who have undergone operations on the adrenal glands. In fact it often appears when least expected and sometimes with alarming suddenness.

The body can only respond effectively to the stress of infection, trauma or a surgical operation if adequate quantities of adrenocortical hormones —especially hydrocortisone and aldosterone—are available. These may be provided either by the normal function of the pituitary-adrenal axis or by an exogenous supply of cortisone or one of its analogues. If inadequate amounts are available to meet the body's needs, adrenal failure follows. The failure may be *acute* if the hormones are absent, or the stress severe, or *chronic* if the deficiency is partial or the stress slight.

Clinical features

The clinical features of *acute* failure or " adrenal crisis " are those of peripheral circulatory collapse and the condition is indistinguishable clinically from oligaemic shock. The signs are collapse, hypotension and tachycardia and, if treatment is not given promptly, death follows rapidly. Hypoglycaemia is an occasional complicating feature.

The early symptoms of *chronic* failure are anorexia and nausea, weakness and abdominal discomfort, and the signs are tachycardia and often slight fever. The late features are vomiting and hypotension which may cause anuria, and sometimes mental changes. Finally the condition becomes acute and the patient may die. Other features are sometimes present. Brown pigmentation of the skin and mouth are seen in Addison's disease and following adrenalectomy for Cushing's Syndrome. Desquamation of the skin, which invariably accompanies the remission of Cushing's Syndrome, is aggravated if adrenal failure develops.

Changes in the serum are common and help to confirm the diagnosis. The sodium and chloride concentrations may be low and the potassium high. The blood sugar may be low. Estimations of adrenal steroids are very helpful in chronic insufficiency but they take too long to be of value in adrenal crisis.

Treatment

The treatment of established adrenal failure is simple, specific and highly effective. In the acute stage nor-adrenaline, infused intravenously, raises

the blood pressure at once and its rate must be adjusted every few minutes. Hydrocortisone is infused at the same time. 100mg. of the hemi-succinate are given at once and again four hours later if necessary.

Cortisone is given intramuscularly as well and by mouth as soon as possible. Within minutes or hours the hydrocortisone takes effect and the nor-adrenaline can be stopped. If hypoglycaemia is suspected glucose should be given intravenously at the start. In the chronic form corti-sone (100 mg.) by mouth is effective within a few hours. Hydrocortisone may be needed if the patient is vomiting.

The cause of adrenocortical failure (Table IV) may lie in the adrenal cortex itself (i.e., primary adrenal failure) or in the anterior pituitary,

TABLE IV
CAUSES OF ADRENOCORTICAL INSUFFICIENCY
Primary Adrenal Failure
Removal—Adrenalectomy
Destruction—Chronic : Addison's disease
                          Acute :   Adrenal apoplexy
Ischaemia—Clamping of Aorta
Exhaustion—Prolonged or severe stress
Dysfunction—Virilizing hyperplasia
    Secondary Adrenal (Primary Pituitary) Failure
Removal—Hypophysectomy
Destruction—Simmond's or Sheehan's diseases
Inhibition—Therapy with Cortisone and its analogues or with ACTH

which fails to secrete ACTH (i.e., secondary adrenal failure). We will discuss the varieties in turn.

Primary adrenal failure

Removal of the adrenals (adrenalectomy) for conditions such as metas-tatic carcinoma, in which adrenal function is normal, rarely causes an adrenal crisis if cortisone cover is given ; but the frequency and severity of crisis in patients with Cushing's Syndrome cannot be over-emphasized. It may follow operation on the first side, even when there is no tumour. The chronic failure which may follow later in any patient who has lost his adrenals is not yet sufficiently well known. The patient may stop taking cortisone, or an infection, an accident, a surgical operation or progression of malignant disease may render the dosage inadequate. The symptoms may be dismissed as those of gastroenteritis, specific treatment is withheld, and the patient dies. Sub-total adrenalectomy, as I have indicated, is no guarantee against adrenal insufficiency, and patients with a small piece of adrenal remaining require additional cortisone in the face of severe stress.

Destruction of the adrenals may be chronic or acute. Patients with *Addison's disease* withstand surgery very badly, and an operation is very likely to precipitate an adrenal crisis. We have seen a near-fatal adrenal crisis after gastroscopy under general anaesthesia and I know of another patient who died following pneumonectomy. Both these patients were known to have Addison's disease and, through ignorance, neither received

adequate support. The problem is more difficult when the Addiso.1's disease has not been recognized before the adrenal crisis develops. A girl of nineteen died in severe shock twenty-four hours after simple appen- dicectomy. Post-mortem her adrenals were found to have been destroyed by tuberculosis. Another woman, aged fifty, underwent hemicolectomy. After operation her blood pressure remained low and could be maintained only with nor-adrenaline. After five days, when no other cause for the hypotension could be found, she was given hydrocortisone intravenously and quickly recovered. Subsequent investigation showed that she had mild Addison's disease.

Acute destruction is caused by haemorrhage into the adrenals. This " *adrenal apoplexy* " sometimes accompanies trauma, which need not necessarily involve the adrenals directly ; it is probably one cause of the so-called " irreversible shock " which fails to respond to blood transfusion.

Adrenal *ischaemia* may occur during operations which involve prolonged occlusion of the aorta and may cause death post-operatively (Rob, 1957).

The adrenals may become " *exhausted* " by prolonged illness, by a severe and lengthy operation or by protracted labour. We have seen three patients in this category. One (Fig. 7) had prolonged gastric retention after
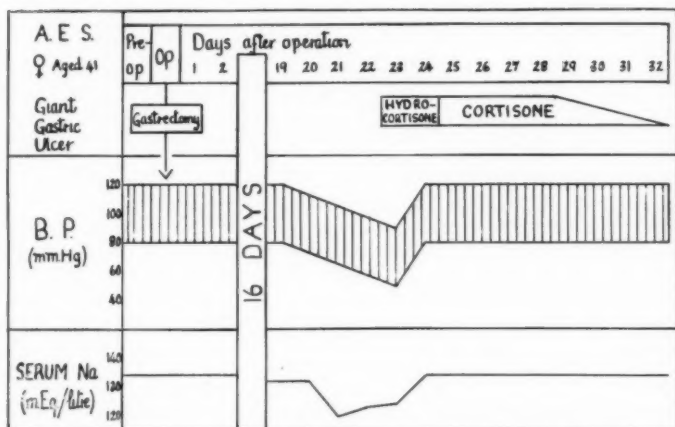
Fig. 7. Adrenal " exhaustion." Simplified diagram showing (i) fall in blood pressure and serum sodium concentration during period of gastric suction and intravenous feeding ; and (ii) response to hydrocortisone.

gastrectomy and was fed intravenously for over three weeks. Towards the end of this time her blood pressure fell to 85/50mm. Hg. and her serum sodium concentration fell (despite normally adequate replacement) to 120m.Eq./litre. Hydrocortisone restored both to normal within twenty- four hours. We have seen a similar condition in a patient following

gastroenterostomy and in another who developed paralytic ileus after transplantation of the ureters. In this type of case the evidence for adrenal failure is the nature of the clinical syndrome and its rapid relief by adrenal hormones. We do not really know that the term " exhaustion " is appropriate. We have no knowledge of the adrenal pathology nor of the production of adrenal steroids. It may be that measurement of the concentration of hydrocortisone in the blood will enable us to learn more about the syndrome.

I have already described the *dysfunction* of virilizing adrenal hyperplasia, in which androgens are formed instead of hydrocortisone. The glucocorticoid deficiency renders these patients liable to episodes of adrenal failure. In infancy the symptoms may be dismissed as those of a " feeding problem" or the condition may be mistaken for pyloric stenosis or gastroenteritis. In later life, if an adrenal tumour is suspected and the adrenals are explored, the patient may die post-operatively even though no adrenal tissue has been removed. I know of several such cases both in infants and adults.

Secondary adrenal failure

Secondary adrenal or primary pituitary failure is rarely so sudden in its onset or so severe as primary adrenal failure. The probable reason is that the production of aldosterone, which is not controlled by ACTH, is unimpaired and the metabolism of electrolytes and water remains relatively normal. Other features, such as hypothyroidism, coma and hypothermia, which are not found in primary adrenal failure, are added complications.

Removal of the pituitary (hypophysectomy) sometimes causes hypotension for several days after operation, but it is not clear whether this is the result of adrenal failure. One patient only, out of forty with advanced breast cancer, developed typical adrenal failure with hypotension and electrolyte changes three weeks after operation. She responded to specific treatment.

Destruction of the pituitary causes Simmond's or Sheehan's diseases, in which the problems are similar to those in Addison's disease. In particular, these patients withstand cold very poorly.

The commonest cause of secondary adrenal failure is *inhibition* of the pituitary by cortisone and its analogues or by ACTH, which are used for the treatment of many conditions. They prevent the normal secretion of hydrocortisone, and the pituitary-adrenal axis may take several months to recover after they have been stopped. If the patient suffers the stress of an operation during this period he may develop adrenal failure. This may occur, for instance, if cortisone or ACTH is used in the treatment of ulcerative colitis and then stopped before colectomy is performed. Many such cases have been described (Slaney and Brooke, 1957) and I have had one.

309

Prevention

How can all these catastrophies be avoided?

(1) By remembering the conditions which pre-dispose to adrenal failure.

(2) If time permits, by investigating adrenal function pre-operatively in anyone suspected of having adrenal insufficiency.

(3) By recognizing the syndromes of adrenal failure and giving specific treatment as soon as the condition is suspected. Hydrocortisone will do no harm and will save life in adrenal failure.

(4) By giving replacement therapy over the period of operation to any patient with potential adrenal insufficiency. The therapy should be similar to that which is used for adrenalectomy. It will render anaesthesia and surgery as safe as they are in patients with normal adrenal function.

(5) All patients who are known to have adrenal insufficiency should be given a card to carry with them always. The following is one which is suitable for patients after adrenalectomy.

M. . . . .

CARRY THIS CARD WITH YOU ALWAYS

1. Your adrenal glands have been removed. It is essential for you to take Cortisone tablets every day ; you will remain in good health only if you do so. Your doctor will give you prescriptions for them. Your dose is .. tablets (.. mg.) .. times a day.

2. The dose may have to be increased temporarily if you develop an illness (e.g., a bad cold), have an accident or have to undergo an operation (e.g., for appendicitis). Show this card to your doctor or to the hospital doctor at the time.

3. If you feel weak or lose your appetite it may mean that you are not taking enough Cortisone. Try taking an extra half tablet twice a day and see if you feel better. If you don't, go to your doctor at once.

In conclusion, adrenal failure is commoner than is generally recognized and may develop unexpectedly in all types of surgery. It can often be prevented if the conditions which may cause it are remembered. It can be treated effectively if it is recognized early.

Mr. President, concerning the adrenals, John Hunter merely remarked that " the capsula renis is a wrong name for those bodies, as they are not attached to the kidneys in all animals ; in the lizard they are placed between the testis and the epididymis." To-day, consideration of the adrenal cortex illustrates the complexity of the animal economy and the dependence of surgery on general biology. If John Hunter had been alive now I believe that he would have found the problems of the " capsula renis " very near to his heart.

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REFERENCES

BONGIOVANNI, A. M., EBERLEIN, W. R., and CARA, J. (1954) *J. clin. Endocr.* **14,** 409.

BULLOCK, W., and SEQUEIRA, J. H. (1905) *Trans. path. Soc. Lond.* **56,** 189.

CROOKE, A. C. (1935) *J. Path. Bact.* **41,** 339.

CUSHING, H. (1932) *Bull. Johns Hopk. Hosp.* **50,** 137.

HARRISON, M. T., MONTGOMERY, D. A. D., RAMSEY, A. S., ROBERTSON, J. H., and WELBOURN, R. B. (1957) *Lancet* **1,** 23.

HUNTER, J. (1861) *Essays and Observations on Natural History, Anatomy, Physiology, Psychology and Geology,* edited by R. Owen, London, JOHN VAN VOORST.

KYLE, J., LOGAN, J. S., NEILL, D. W., and WELBOURN, R. B. (1956) *Lancet* **1,** 664.

LANDES, R. R., and RANSOM, C. L. (1957) *Surg. Gynec. Obstet.* **105,** 268.

MONTGOMERY, D. A. D., and WELBOURN, R. B. (1957) *Brit. J. Surg.* **45,** 137.

ROB, C. (1957) *Operative Surgery,* edited by C. Rob and R. Smith, **7,** 126.

ROLLESTON, H. D. (1936) *The Endocrine organs in health and disease.* London, Humphrey Milford.

SLANEY, G., and BROOKE, B. N. (1957) *Lancet* **1,** 1167.

SPRAGUE, R. G., KVALE, W. F., and PRIESTLEY, J. T. (1953) *J. Amer. Med. Ass.* **151,** 629.

THOMPSON, K. W., and EISENHARDT, L. (1943) *J. clin. Endocr.* **3,** 445.

WELBOURN, R. B. (1957a) *Postgrad. med. J.* **33,** 15.

———— (1957b) *Irish J. med. Sci.* no. 381, p. 401.

WILKINS, L., BONGIOVANNI, A. M., CLAYTON, G. W., GRUMBACH, M. M., and VAN WYCK, J. J. (1955) *The human adrenal cortex,* p. 460. London, Ciba Foundation.

SIR HARRY PLATT, BT.

SIR HARRY PLATT left for India and Ceylon on 30th October on a lecture-tour arranged by the British Council. He will visit a number of the main hospital and medical school centres in India, Pakistan and Ceylon during the months of November, December and the early part of January, and will also make a number of special hospital visits on behalf of the College. During his visit to India Sir Harry will be taking part in the meeting of the Association of Surgeons of India, at which he is to give a talk, and the meeting of the Orthopaedic Association. He will also attend a conference of the India Medical Association in Calcutta. He will return to the United Kingdom in the middle of January.

SPREAD OF INFECTION IN HOSPITALS

Lecture delivered at the Royal College of Surgeons of England
on
9th April 1958
by
R. A. Shooter, M.D.
Bacteriologist, St. Bartholomew's Hospital, Reader in Bacteriology, University of London

MY TITLE, THE spread of infection in hospitals, covers a very wide field. I propose turning at once to staphylococcal infections because in the last few years these infections have been seen increasingly often, and have not always been controlled by conventional measures. As a general background I would like to suggest to you that staphylococcal infection occurs in three main ways. It may originate at operation, reaching the wound from the air or from some other source, such as a member of the surgical team. It may occur in the ward, the staphylococci coming from the patient himself or from some other patient or member of the staff. This method of infection probably accounts for sporadic wound sepsis and its frequency is probably directly related to the standard of asepsis in the ward. Thirdly, wards or entire hospitals may be invaded by particularly dangerous strains of staphylococci. These strains have caused epidemics of infection, sometimes involving the staff as well as the patients, and so far attempts to stop their spread have only met with limited success.

If you will agree that epidemics of staphylococcal infection are confined to only a few strains, it explains why serious staphylococcal infection has a rather patchy distribution. One hospital may be free from dangerous strains, while another may not, and differences may occur from ward to ward. These dangerous strains have almost certainly been produced through the use of antibiotics, and since the war the whole subject of staphylococcal infection has received a great deal of attention. Some of the methods used are relatively new and I would like to digress for a few minutes to look at some of the practical aspects involved in the investigation of hospital infection.

For the last twenty years pathogenic staphylococci have been recognized in the laboratory by their ability to clot plasma. This is a simple test, but unfortunately no simple test has yet been devised which is capable of distinguishing between staphylococci which will cause severe or only mild infection. The lack of such a test is felt principally when dealing with carriers. In hospitals up to 80 per cent. of the staff may carry pathogenic staphylococci in their noses, and sometimes in other parts of the body. As the carriage rate among patients may reach the same level and as the enterprising bacteriologist may isolate staphylococci from the majority of articles in the ward that he examines, a simple laboratory method of testing the virulence of staphylococci would be most welcome.

312

The most valuable recent contribution has been the introduction of phage typing. Many phage types of staphylococci exist and as these types are reasonably stable, it is frequently possible to trace staphylococci to the infection or carrier from which they have been shed.

It was by the use of this method that Dr. Mary Barber showed at the British Postgraduate Hospital at Hammersmith that when penicillin-resistant staphylococci were isolated from a wound infected previously with penicillin-sensitive staphylococci, the change was due to cross-infection with a new staphylococcus, and not to acquisition of resistance by the original one (Barber, 1947 ; Barber and Whitehead, 1949). Subsequent investigations of cross-infection have nearly all made use of phage-typing, and some have been wholly dependent on it.

Since the war much use has been made of slit-samplers for the examination of air. In these machines (Bourdillon, Lidwell and Schuster, 1948) air drawn through the slit is blown on to revolving culture plates. After incubation colonies develop where bacteria-carrying particles have landed on the plate. As the volume of air being examined is known, it is possible to gauge the number of bacteria per cubic foot of air. There are two hazards in interpretation. The least is that a dust particle carrying bacteria will produce a single colony whether it is carrying two bacteria or 200. The more serious objection is that there is an almost irresistible temptation to regard the improvement of slit sampler counts as an end in itself and to forget that what really matters is the prevention of clinical infection.

What matters most to the patient is that his wound heals up without becoming septic, and although it may be tempting to use bacteriological criteria like bacterial air counts, it is by the avoidance of sepsis that preventive measures should be judged. Impressions of the amount of sepsis occurring are apt to be misleading, and it is unusually well kept notes which allow one to look back and to be certain how wounds healed. Without accurate information about the amount of sepsis, investigation of any outbreak becomes much more difficult.

At Bart's we have found one solution to lie in the keeping of a wound book in which the name of every patient undergoing operation is entered, with details of the operation, surgeon responsible and so on. Before the patient leaves hospital a note is made of the state of the operation wound. We use two simple standards, the wounds being either healed or infected—infected being when pus can be seen. At intervals the book is examined, and after excluding patients whose wounds were contaminated at the time of operation, the sepsis rate for clean wounds is recorded.

There are many possible ways of arriving at this rate and you may think the one I have described is too simple. It is however surprising how often such records are not kept, and without such records investigations are severely handicapped. As in so many other things keeping an accurate record depends on finding some person who is interested, and it will be

clear that junior members of a surgical unit can hardly be expected to take the task seriously if their chief is not interested.

Finally I would like to draw your attention to titanium chloride as a substance for producing smoke clouds. If you wish to see if hospital air is being sucked into your operating theatre you do not have to wait until a slit sampler is available, but you can do so yourself very simply by watching the movements of smoke clouds.

Infection arising at operation

It is often possible to decide if a wound has been infected at operation or in the ward. In favour of the former are pus developing deep in the wound, infection present at or before the first dressing, and early indication of sepsis on the temperature chart.

As time has gone by much has been learnt of infection arising at operation, and once the cause is known, there should be little difficulty in preventing infection of this sort. To a very large extent each surgeon by strict observance of recognized aseptic practices can control the amount of sepsis occurring in his patients. On occasions, however, sepsis may occur through some factor beyond the immediate control of the surgeon in charge. To assist you in recognizing such an event if it comes your way, I would like to outline some of the possibilities.

Infection from a carrier

In view of the frequency with which hospital staff carry staphylococci, it is fortunate that conventional theatre techniques are normally sufficient to prevent carriers in the surgical team from infecting patients. From time to time this may happen, and perhaps is particularly likely to happen if the surgeon is himself suffering from staphylococcal infection of the skin or subcutaneous tissue (e.g., McDonald and Timbury, 1957). An example of what is probably an unusual form of infection was given by Devenish and Miles (1939) in a paper which set a high standard for future workers in this field. It described the surgical practice of a unit at University College Hospital, comprising the work of four surgeons. Of these twenty of 141 operations done by surgeon A became septic, whereas only two of 120 operations done by surgeons B, C, and D, did so. Devenish and Miles ascribed this to the fact that surgeon A was a nose and hand carrier of staphylococci and suggested that the staphylococci had leaked through perforations in the surgeon's gloves into the wound. They pointed out that many gloves after operations were found to have minute tears and perforations.

Recently we have been able to report a similar experience (Shooter, Griffiths, Cook and Williams, 1957). In one of our surgical units twenty-four of eighty-three patients undergoing clean operations developed infected wounds thought to be infected at time of operation. These wounds were found to contain staphylococci of a single phage type and only one

314

carrier of this type could be found in the theatre team. Confirmatory evidence that the carrier was responsible was provided by study of the wound book. Of the forty-five operations in which he took part twenty-one became infected, while of the thirty-eight patients operated on in his absence only three did so. Our carrier was a nose and hand carrier of staphylococci and presumably introduced infection through perforations in his gloves, about 30 per cent. of which are found to be imperfect after operation. In view of this high rate it is perhaps surprising that infection occurs so infrequently in this way.

Infection from air-borne bacteria

Twenty years ago Wells and Wells (1936 ; 1938) and Hart (1937 ; 1938) in America pointed out that the air in operating theatres contained germs, and suggested that these germs might be responsible for wound infection. At the time these views were not generally accepted in this country. More attention was paid some ten years later to a series of papers which described the effect of ventilation on the bacterial content of air in a dressing room attached to a burns unit, and in operating theatres (Bourdillon and Colebrook, 1946 ; Bourdillon, McFarlan and Thomas, 1948 ; Girdlestone and Bourdillon, 1951).

Since then a number of published and unpublished studies have confirmed that in some circumstances the air of operating theatres may contain undesirable bacteria, and, more importantly, that measures to reduce the bacteria in the theatre air may lead to sharp falls in the number of patients whose wounds are infected at operation. One such study was conducted by Blowers, Mason, Wallace and Walton (1955). Working in a chest unit they were able to reduce their infection rate by a variety of measures, of which, in their opinion, the most important was the provision of effective positive pressure ventilation.

We reported from Bart's another set of observations in which the prevention of infection was linked more closely with a change in the theatre ventilation (Shooter, Taylor, Ellis and Ross, 1956). Our surgical units consist of male and female wards connected by a corridor with an operating theatre. For some years one of these units had experienced a sepsis rate in clean operations of about 10 per cent., and no obvious faults in technique were found to be responsible. Phage typing of the staphylococci showed that some general source was probably responsible for infection as from sixteen wounds eleven different phage types of staphylococci were isolated. Staphylococci of similar phage types were isolated from the wards, the corridor from the wards to the theatre and the operating theatre, and tests with smoke showed that there was a slow but steady air movement from the wards along the corridor to the theatre. In the theatre the ventilation was controlled by a number of extract grilles and one small input fan, but far more air was extracted than was blown in, so that there was a constant suction of air from the corridor under and around the doors

315

into the theatre. By blocking the extract grilles and increasing the amount of air blown into the theatre it was possible to reverse the air flow, and for the first time air was blown from the theatre out to the corridor. This led to an immediate improvement in the bacterial air counts in the theatre, and a drop in the infection rates for clean cases from about 10 per cent. to 1 per cent. or less. The reduction has been maintained.

Once the possibility that air-borne bacteria may cause infection has been accepted, the main principle of theatre ventilation becomes clear. In hospitals staphylococci are most numerous in the wards and the worst fault that a ventilation system can have is that it sucks contaminated ward air into the theatre. Air movement in and out of theatres can easily be tested by smoke and it is worth checking that a system designed to give plenum or positive pressure ventilation is in fact doing so. In design there is a good deal to be said for allowing all or nearly all the air blown in to find its way out through doors, as air removed through extraction vents is no longer available to sustain outward air movements at the entrance to the theatre. It is also worth remembering that even if no extract fan is in use, thermal currents may be responsible for sucking air from the colder corridor into the warmer theatre.

Provided that air moves from the operating theatre out to the rest of the hospital and not *vice versa* it is probably of minor importance which way air moves in the theatre itself. This point is under discussion. It arises at all because there is no practical method of stopping staphylococcal carriers shedding staphylococci and because carriers are so numerous that there is no reasonable hope of having surgical teams—or patients—none of whom are carriers. We obtained some evidence that when incoming air was blown in horizontally at ceiling height, with the intention of disturbing the surgeon as little as possible, a stagnant pool of air might develop over the operation table into which staphylococci shed by carriers might drift. When the incoming air was directed towards the table and the stagnant pool was dispersed, there was a sharp improvement in the sepsis rate. Measures which should be taken to reduce the shedding of staphylococci by carriers include restriction of movement in the theatre and a ban on the entry to the theatre of bedding, and particularly blankets, from the ward.

Infection arising in the ward

As in the theatre there is no doubt that under ordinary circumstances the amount of staphylococcal infection occurring in a ward will depend on the standard of asepsis practised by the medical and nursing staff. But, as before, infection may occur in the best run units. In contrast to the theatre it is not certain how these infections arise and at the moment they are not entirely controlled by standard medical and nursing practices. Infections of this sort are caused most often by antibiotic-resistant staphylococci. It is probable that the world-wide use of antibiotics has

produced a number of strains of staphylococci which differ from their predecessors in being able to infect people more easily. They may, too, cause more serious infections, but as many of these infections are resistant to chemotherapy, it is not easy to decide this point.

The clearest example of such a strain is provided by staphylococci of phage type 80. This strain, first described in Australia by Rountree and Freeman (1955), has appeared in the South of England and has spread to the West and slowly towards the North (see, for example, Gillespie and Alder, 1957). In many of the hospitals in which it has been found it has been associated with epidemics of infection, including, characteristically, outbreaks of boils and carbuncles among the nurses.

In one of our own wards we have been able to produce evidence that some strains of *Staph. aureus* are liable to cause sepsis, while others are much less likely to do so (Shooter, Smith, Griffiths, Brown, Williams, Rippon and Jevons, 1958). In a period of eight months we isolated some 186 different types of staphylococci from the staff, patients, air and inanimate objects, but only ten of these types caused infection in the ward and only three were responsible for disease in more than one patient. These three types were all resistant to tetracycline. In contrast, the failure of the other staphylococci to cause infection was not due to lack of opportunity. Three types, for instance, were present for many weeks, sometimes in large numbers, as the predominant staphylococci in the ward, but without causing any sepsis which we could see.

Methods which have been suggested for the control of staphylococcal infection in wards

As it is not known with certainty how staphylococci which cause infection spread in a ward, methods of control have so far to be based on assumptions. Infections due to non-epidemic types of staphylococci can be prevented by accepted methods of asepsis. Much time and thought has been devoted in recent years to limiting the spread of epidemic-producing types of staphylococci. I would like very briefly to look at some of the methods which have been devised.

Dust elimination

Working in a fever hospital Wright, Cruickshank and Gunn (1944) suggested that measures which reduced the general air counts of bacteria also reduced the cross-infection rate with haemolytic streptococci. The general air count is largely a reflection of activities which stir up dust, and several methods have been employed to reduce dust and lower air counts. Much of the ward dust comes from blankets, and oiling blankets, and floors—so that the dust does not blow but stays on the floor as fluffy aggregates—leads to a sharp fall in air counts. The difficulty is that prevention of streptococcal spread in this way has not been confirmed, and several groups have shown that staphylococcal cross-infection rates

317

are unaffected (e.g., Clarke, Dalgleish, Parry and Gillespie, 1954 ; our own experience). No one would advocate going back to dry dusting, or oppose the use of vacuum cleaners, but there is now little enthusiasm for oiling floors or bedding.

Treatment of bedding

Sheets and pillow cases present no problem, because cotton goods can be washed at a temperature which will kill staphylococci. Blankets are in a different category, as, if they are washed at a temperature high enough to kill staphylococci, they will be damaged. This effect of heat has two results. In the first place there is a reluctance to wash blankets frequently, and in the second when washed, blankets retain some of the staphylococci they started with, and may even acquire new staphylococci from other blankets in the laundry. Among the remedies which have been put forward has been the washing of blankets in a disinfectant solution (Barnard, 1952 ; Blowers and Wallace, 1955). An alternative is to attempt to sterilize blankets with formalin (e.g., Gillespie and Alder, 1957). A somewhat different approach is to discard woollen blankets and use blankets made of some substance that can be boiled, such as cotton, Turkish towelling or synthetic polyester fibre (Blowers, Potter and Wallace, 1957).

These measures at first sight seem rational. If, however, staphylococci resemble streptococci in being dangerous only within a short time of liberation, they would appear to be unlikely to make much impression on the transfer of virulent staphylococci. In view of the current interest in this aspect of cross-infection, a trial in which the effect of bedding on sepsis is observed is badly needed.

Treatment of carriers

Until recently the treatment of carriers has not been profitable. This has been partly due to the large number of carriers involved and partly because of the lack of an effective method of treatment. There are now better prospects of clearing the carrier state. A number of substances (e.g., neomycin) can be applied to the nose with a reasonable hope of removing staphylococci, and with very little chance of forming resistant bacteria. Some of the treatment failures in the past were almost certainly due to treating the nose only, and leaving other carriage sites on the body untouched. Hare and Ridley (1958) have shown that staphylococci may multiply on parts of the body other than the nose, and particularly perhaps on the perineum, and treatment must take this into account. One method which has been used with success has been the application of neomycin cream in the nose combined with the issue to the carrier of hexachlorophene soap for use as toilet soap. These newer methods of treating carriers open interesting prospects in the control of staphylococci, and results in wards where they are being applied will be awaited with interest. It is probably necessary to remember that, except in exceptional

circumstances, once carrier treatment is begun, it will need to be continued for a considerable time. Some carriers appear to be almost permanent hosts of staphylococci and to rid them of staphylococci by a short course of treatment merely leaves them waiting for recolonization by the first staphylococcus they encounter.

Chemotherapy

A new antibiotic, as effective as penicillin against haemolytic streptococci, and to which staphylococci do not become resistant, would solve the problem of staphylococcal infection. Until there is such an antibiotic chemotherapy will continue to produce resistant strains. To some extent the pace at which such strains are produced can be restricted by limiting the use of antibiotics. As an additional measure attempts are being made to stop the formation of resistant organisms by the prescription of two antibiotics together. In the laboratory this is effective, but as a general policy for use in the treatment of patients, it is a method which has still to be proved to work. Our own experience has not been encouraging.

Isolation

Isolation is, of course, only possible when facilities for it exist. It is also clear that for staphylococci, isolation means removal to a separate ward or room. Effective isolation retaining the patient in the ward cannot yet be done. In the study of staphylococci in a surgical ward already mentioned, we isolated in a ward side-room and nursed with barrier nursing ten patients with tetracycline-resistant staphylococci. Despite evidence that these staphylococci were spreading to infect other patients before isolation, after isolation there was only one secondary case of infection in the ward. I would unhesitatingly recommend isolation of this sort to a surgical unit which had a fair record of infection in the past, and which wished to avoid trouble in the future. It is more difficult to know what to do when confronted by a unit in which a strain of staphylococcus such as type 80 is well entrenched. It is in fact a measure of the seriousness with which outbreaks of infection due to type 80 come to be regarded that some hospitals have closed wards with the sole purpose of eliminating type 80 from the staff, patients and the ward and its contents.

It is too soon to say how successful this policy is going to be. Where it has failed, staphylococci of the epidemic type have been brought back by members of the staff, patients coming from other hospitals (or nowadays in some areas from their own houses) and possibly by failure to disinfect the ward. I suspect that when it is possible to treat carriers among the nursing and medical staff, when facilities for isolation exist and when it is practicable to test patients on admission with a view to isolating carriers

of the epidemic type, it will be possible to run a ward with little or no epidemic staphylococcal infection, even if such infections are common in other hospitals.

REFERENCES

BARBER, M. (1947) *J. Path. Bact.* **59,** 373.

———— and WHITEHEAD, J. E. M. (1949) *Brit. med. J.* **2,** 565.

BARNARD, H. F. (1952) *Brit. med. J.* **1,** 21.

BLOWERS, R., and WALLACE, K. R. (1955) *Lancet* **1,** 1250.

———— MASON, G. A., WALLACE, K. R., and WALTON, M. (1955) *Lancet* **2,** 786.

———— POTTER, J., and WALLACE, K. R. (1957) *Lancet* **1,** 629.

BOURDILLON, R. B., and COLEBROOK, L. (1946) *Lancet* **1,** 561, 601.

———— LIDWELL, D. M., and SCHUSTER, E. (1948) *Spec. Rep. Ser. med. Res. Coun. (Lond.)* **262,** 12.

———— McFARLAN, A. M., and THOMAS, J. C. (1948) *Spec. Rep. Ser. med. Res. Coun. (Lond.)* **262,** 241.

CLARKE, S. K. R., DALGLEISH, P. G., PARRY, E. W., and GILLESPIE, W. A. (1954) *Lancet* **2,** 211.

DEVENISH, E. A., and MILES, A. A. (1939) *Lancet* **1,** 1088.

GILLESPIE, W. A., and ALDER, V. G. (1957) *Lancet* **1,** 632.

GIRDLESTONE, G. R., and BOURDILLON, R. B. (1951) *Lancet* **1,** 597.

HARE, R., and RIDLEY, M. (1958) *Brit. med. J.* **1,** 69.

HART, D. (1937) *Arch. Surg.* **34,** 874.

———— (1938) *Arch. Surg.* **37,** 956.

McDONALD, S., and TIMBURY, M. C. (1957) *Lancet* **2,** 863.

ROUNTREE, P. M., and FREEMAN, B. M. (1955) *Med. J. Aust.* **2,** 157.

SHOOTER, R. A., TAYLOR, G. W., ELLIS, G., and ROSS, Sir J. Paterson. (1956) *Surg. Gynec. Obstet.* **103,** 257.

———— GRIFFITHS, J. D., COOK, J., and WILLIAMS, R. E. O. (1957) *Brit. med. J.* **1,** 433.

———— SMITH, M. A., GRIFFITHS, J. D., BROWN, M. E. A., WILLIAMS, R. E. O., RIPPON, J. E., and JEVONS, M. P. (1958) *Brit. med. J.* **1,** 607.

WELLS, W. F., and WELLS, M. W. (1936) *J. Amer. med. Ass.* **107,** 1698.

———— (1938) *Amer. J. publ. Hlth.* **28,** 343.

WRIGHT, J., CRUICKSHANK, R., and GUNN, W. (1944) *Brit. med. J.* **1,** 611.

RECENT OVERSEAS VISITORS TO THE COLLEGE

RECENT OVERSEAS VISITORS to the College have included Mr. C. J. Kaplan, F.R.C.S., of Durban, who delivered a Hunterian Lecture on 30th September ; and Dr. Carl Bode, Cultural Attaché at the United States Embassy in London, and Dr. and Mrs. A. J. Britten-Jones of Adelaide, who attended the Monthly Dinner in October.

THE CENTENARY
of the
GENERAL COUNCIL OF MEDICAL EDUCATION AND REGISTRATION
of the
UNITED KINGDOM
(THE GENERAL MEDICAL COUNCIL)
1858-1958
IN RELATION TO MEDICAL EDUCATION
by
Sir Ernest Finch, M.D., D.Sc., M.S., F.R.C.S.
Late Honorary Surgeon, Royal Infirmary, Sheffield, and late Professor of Surgery, University of Sheffield

The origin of the Council

THE MEDICAL ACT of 1858 is by far the most epoch-making milestone in the history of medical education and practice. It established a statutory body, the General Council of Medical Education and Registration of the United Kingdom, now known as the General Medical Council (1951), which celebrated the centenary of its inauguration in October this year. No less than seventeen Bills had foundered in Parliament between 1840 and 1858 before this, the first modern major Medical Act, received the Royal Assent on 2nd August 1858. Later "between 1870 and 1881 upwards of twenty Medical Bills (not all acceptable to the Council) were lost in Parliament before the second major Act was passed in 1886." The purpose of the Act which came into effect on 1st October 1858, by which the Council had been established and given the responsibility to carry out, was to enable the public to distinguish between qualified and unqualified practitioners by the compilation and publication annually of the Medical Register; to secure complete reciprocity of practice in all parts of the United Kingdom; and the publication of a national Pharmacopoeia containing reliable standards for medicines. The Act also contained " half a dozen inconspicuous lines authorizing the Council to erase from the Register the name of any practitioner convicted of a criminal offence or 'judged after due inquiry to have been guilty of infamous conduct in any professional respect'." This provision, which attracted little notice in 1858, is the basis for the belief of the laity that the primary concern of the Council is with professional ethics and discipline. The Council, which assembled for the first meeting on 23rd November, with Sir Benjamin Brodie as President, having been constituted with regard to its primary responsibility for medical education, was comprised of medically qualified representatives of the nineteen Licensing Bodies then functioning; also six members who had been nominated by Her Majesty with the advice of Her Privy Council under the auspices of which the Council had been established. The Act of 1858 terminated a long period of wrangling and

clash of vested interests which had continued for centuries concerning medical education and practice, but, during the hundred years in which the Council has been functioning, order has been restored from chaos by the tactful procedures adopted by the successive Presidents and Members ably helped by the Administrative Officers. The Presidents have always emphasized the fact that the Council was established " for the good of the public, and not for the protection of the medical profession," yet, by the broad sympathetic understanding by the Council of the difficulties and prestige involved, the profession has always been conscious that its legitimate interests have not been abused. The preamble of the Act stated that " it is expedient that persons requiring medical aid should be enabled to distinguish qualified from unqualified practitioners." The publication of the Medical Register was very necessary as " the Census returns of 1841 suggest that nearly 5,000 of the 15,000 persons then practising in England were unqualified." It was also quite apparent that it was necessary to formulate a scheme for education as when the Council began to enquire and obtain information from the Licensing Bodies " it learnt with concern in 1862 that among 1,750 students preparing for the examinations of the Society of Apothecaries no more than 350 had passed a preliminary examination in general education." The Act anticipated and Parliament demanded an early publication of the Medical Register ; this was achieved in July 1859. A schedule in the Act had specified the qualifications of each of the nineteen Licensing Bodies which would in future entitle the holders to registration. The professional titles conferred by these Licensing Bodies, after tests of varying standards, had little more than local value. " An Edinburgh practitioner might be unable to extend his practice legally to London, Dublin, or even Glasgow." A graduate of London University was legally prohibited by two Acts of Parliament from practising as a physician in London ; hence the difficulty for the public to distinguish the qualified from the unqualified persons and the need for reciprocity to be established for qualified practitioners to have freedom in choosing the place in which they might practice. The training of future medical practitioners and prevention of the untrained from practice had been controlled for centuries by various Acts of Parliament, and it is only by a study of these that the details embodied in the Act of 1858 can be fully appreciated so that it is possible to see the chaos that this Act rectified.

The background

The training for and practice of medicine had resulted in the development of three distinct grades of practitioners namely surgeons, physicians and apothecaries, each proud and jealous of their privileges and interests. The treatment of the sick had been in the hands of the ecclesiastics in the monasteries, where attention was paid to care rather than cure, the church rather than the clinic and last aid rather than first aid. In 1163 the meeting of the Council of Tours, under Pope Alexander III culminated in the

322

edict *Ecclesia Abhorret a Sanguine.* The consequence was that the ecclesiastics ceased to do surgery and continued to practise only the healing art of medicine. The practice of surgery was passed on to the Barbers, who seized the opportunity of practising surgery on their own account, calling themselves Barber-Surgeons ; they practised both barbery and surgery. Finally the general practice of surgery was relegated to "barbers, bath keepers, sow gelders and wayfaring mountebanks."

The Barber-Surgeons

The Barbers formed a guild, the early record of which in 1307 is in an Ordinance preserved at the Guildhall. There is also a record of 1369 of a Guild of Surgeons in which two Masters were given power to report the faults of unskilled surgeons. In 1376 the Guild of Barbers obtained an Ordinance that " two Masters should be appointed annually to direct and rule the craft, to inspect instruments and medicines used and to see that none should be admitted to the franchise except after attestation of their skill by good examination." The Guild of Surgeons in 1423 sought an alliance with the Physicians (the first Conjoint Board) in order to challenge the surgical privileges of the Barbers ; both projects were unsuccessful so the Guild of Surgeons continued as a separate body. In 1462 Edward IV recognized the surgical privileges of the Barbers by Letters Patent and granted a Charter to the " Freeman of the Mystery of Barbers of the City of London practising surgery." It is from this Charter which confirmed the Ordinance of 1376 that the Royal College of Surgeons of England dates its constitutional history. The two Masters of the Company of Barbers were empowered to inflict punishment upon offenders by fines, imprisonment or other reasonable means as it was laid down that no person was allowed to practise *surgery* in London and its suburbs unless first approved by the Masters of the Company. In 1493 the Guild of Surgeons formed an alliance with the Barbers Company to act in unison in all matters relating to surgery and in the examination and government of its practitioners.

In 1540 the two companies were united by Henry VIII as " The Masters or Governors of the Mystery and Commonality of Barbers and Surgeons of London." This new body was to enjoy all the rights and privileges previously granted to each company. There was opposition to making the practice of surgery a closed profession, so, in 1543, " an Act that persons being no common surgeons may minister outward medicines " was passed and thereby unlicensed practitioners were allowed to treat outward swellings and sores with herbs and ointments. The company in 1555 drew up regulations relating to the examination of candidates for its License to practise and thirteen examiners were appointed ; this regulation marks the origin of the Court of Examiners of the Royal College of Surgeons of England. A further Charter was granted in 1605 with reference to the examinations and to prohibit from practising " ignorant persons and such as wilfully refused to be examined."

323

The Physicians

There was much legislation during the Tudor period relating to medical education and practice. An Act, to protect the interests of physicians, no doubt inspired by Thomas Linacre, was also passed in 1511 providing that no one should practise *medicine* within the City of London or within seven miles of it unless he had been examined and approved by the Bishop of London or the Dean of St. Pauls with the help of doctors of physic or those expert in surgery. Outside London the examinations were to be held by the Bishop of the diocese or his Vicar-General with the aid of expert persons. This Act, like that of 1858, was also to exclude the unqualified practitioner. The preamble draws attention to the ignorant persons " exercising the science and cunning of physic, to the perfect knowledge whereof be requisite both great learning and ripe experience." This was followed in 1518 by the foundation, by Letters Patent, of the College of Physicians in London (it became Royal in 1860) with Thomas Linacre as the first President. A further Act in 1540 defined Medicine as including surgery and gave physicians the right to practise when and where they wished, but an Act of 1543 forbade surgeons from practising medicine. The College of Physicians by the Act of 1518 confirmed later by the Statute of 1521 was invested with the control and authorization of drugs of a recognized standard.

The Apothecaries

The Apothecary was an old established calling. Recipes to be dispensed for the treatment of disease are mentioned in the Ebers and Edwin Smith papyri. Hippocrates (460 B.C.) taught the importance of observation, comparison and therapeutic treatment of disease based on experience ; about 200 different drugs are recommended in the writings. The materia medica prepared by Dioscorides (A.D. 77) was more or less unchallenged until the Renaissance. The recipe and method of preparation by the Apothecary of the holy anointing oil and incense are mentioned in the book of Exodus (xxx 25. 35). The Arabian Physicians Rhazes (860-926) and Avicenna (980-1037) both issued what might be called a pharmacopoeia. The Guilds of Pharmacists also in Florence, Barcelona, Saragossa, Augsburg and elsewhere issued pharmacopoeias. It is not surprising therefore that the Act of 1518 contained a special provision authorizing the College of Physicians in London to appoint four persons with the duty " of the correction and government of physic and its professors together with the examination of all medicines and the punishment of offenders by fine, imprisonment or other means." This duty was discharged by the College for 340 years (1518-1858). These visitors appointed by the College, empowered by statute to destroy any drugs found to be defective after investigation, were the forerunners of the inspectors and analysts appointed under the " Sale of Food and Drugs Act " (1875). The Act of 1518 also enacted that " no person, except a

graduate of Oxford or Cambridge, without dispensation, was to be permitted to practise physic throughout England unless he had been examined and approved by the President and three Elects of the College."

The third grade of medical practitioners was the Apothecary, who had always been a shopkeeper selling sweets, preserved fruits and dispensing drugs. Aspirants to the calling had to serve an apprenticeship of at least five years, and a curriculum was laid down which had to be fulfilled by the apprentice.

At first the Apothecaries did not prescribe but only dispensed medicines but later began to prescribe as well, so the College of Physicians naturally objected. They gradually became the unqualified practitioners of medicine, who attended an individual afflicted with a disease not requiring external or manual aid. James I, having granted a Charter in 1606 to unite the Apothecaries with the Grocers, granted another Charter to the Apothecaries in 1617 " to disunite, disjoin, separate and dissociate the Apothecaries of our City of London from the Freeman of the Mystery of Grocers of the same City." This established the Society of Apothecaries which from 1617 to 1858 exercised the chief influence on the organization of medical education in the country. The foundation of the Society synchronised with the beginnings of the advances in medical science. In 1633 the Society unsuccessfully invited the College of Physicians to take part in the examination of those apprentices who wished to become freemen of the Society after fulfilling the curriculum. In 1804 a local group of Apothecaries in Lincolnshire and the Midlands put forward a scheme for the improvement of medical education and practice. The scheme included the publication of a Register of those qualified to practise any of the professions of physician, surgeon, apothecary, midwife or veterinary practitioner. No support was given to this scheme by the Corporate Bodies. In 1813 a further scheme was suggested by an Association of Surgeons and Surgeon Apothecaries. A Bill was drawn up to be presented to Parliament which suggested the formation of a Central Body to control medical education and practice consisting of representatives of the Corporate Bodies and the establishment of a Register of medical practitioners. It also laid down that all practitioners were to serve an apprenticeship and pass examinations. The Bill was dropped as it received no support from the Corporate Bodies, so a tentative suggestion was made that an altogether independent fourth body (the first suggestion of a General Medical Council) should be set up to regulate medical education and practice ; this was only realized in 1858. Further Bills were drafted but dropped owing to one or other Corporate Body raising some particular objection. Finally a Bill known as the Apothecaries Act was introduced into Parliament on 27th February 1815, passed on 11th July, receiving the Royal Assent on 12th July. The Bill made no change in the Charters or privileges granted to the Corporate Bodies except that though the College of Physicians retained its privileges with regard to

325

practice in and around the City of London, elsewhere in England and Wales, no person could practise medicine unless he had fulfilled a curriculum and passed an examination conducted by examiners appointed by the Society of Apothecaries or was a graduate in medicine of Oxford or Cambridge, or a Licentiate or Extra Licentiate of the College of Physicians.

The Apothecaries Act

By this Act of 1815 it had become possible to introduce for the first time organized teaching of clinical medicine and surgery as a necessary requirement for the qualifying examinations of the Society. The leaders of the Society insisted as far as possible on a sound preliminary education and a definite period of instruction in approved hospitals in addition to a period of apprenticeship with a general practitioner, who was one entitled to practise both medicine and surgery. It was the requirement of hospital practice, which could be given during the period of apprenticeship, that led to the establishment of hospital medical schools in London and the chief towns of England and Wales. This period of hospital instruction and practice was required by no other Corporation at this time ; the College of Physicians did not require it until 1834.

The implementation of the Medical Act (1858)

Such was the position when the Medical Act of 1858 was put into effect on 1st October and the General Medical Council was given the authority to blend the conflicting interests into one co-ordinated whole. The qualifications in existence in 1858 gave license to practise either medicine *or* surgery *or* both. Midwifery was not exalted to rank with medicine or surgery as a statutory requirement for qualification until the Act of 1858. Up to 1852 neither the College of Physicians nor the Royal College of Surgeons had encouraged the practice of midwifery by their licentiates but it was recognized as an essential subject in the Recommendations and requirements of the General Medical Council in 1867.

The division of Medicine into *medicine* and *surgery* had been made more and more definite by legislation before 1858 ; the Act of 1540 was an anachronism allowing a physician to practise surgery with no previous training. " In the times of Greece and Alexandria medicine and surgery were one, to the clear eye of the Greek they could not be sundered. The division of Medicine into *medicine* and *surgery* had its roots not in nature, not even in natural artifice but in clerical, feudal and humanistic conceits" (" *The Historical Relations of Medicine and Surgery*. Sir T. Clifford Allbutt." Macmillan London, 1905). He continues : " That in later ages in Europe the field of surgery has been avoided by the physician and the field of medicine forbidden to the surgeon and that by this unnatural schism medicine has suffered much bane, is illustrated in history as it is day by day in the *fragmentation of our work*. The limits should be by personal choice on natural lines, not by the service of mediaeval rules."

326

He also relates the conditions of education when he was a student. "In the days of my graduation (1861) in my own University (Cambridge) we were not examined in surgery. We were only called upon to produce a certificate of having attended a course of lectures on Surgery and Obstetric Medicine . . . . In the examination indeed surgery was expressly excluded, for the requirement was ' The medical treatment of surgical and obstetrical disease.' During the time of my studentship at St. George's I believe I never entered a surgical ward."

In view of the foregoing remarks it is apposite to consider how in 1858 and subsequently, the General Medical Council has by its suggested Recommendations, not *Regulations*, broken down to some extent the mediaeval fragmentation of medical education and practice, which has again been stressed by recent legislation. " The Act empowered the Council to ask Licensing Bodies for full information about their current courses of study and examination, and to send Visitors to attend and report upon any examinations held by the Bodies. The Council itself had no power to refuse to register any scheduled qualification, however inadequate the conditions on which it was granted, but it could represent to the Privy Council that a qualification granted on insufficient conditions ought no longer confer a right to registration. The Privy Council could then order that the qualification should cease to confer such a right." To raise the standard of education the Council proceeded to issue " Recommendations " or " Resolutions " to indicate the minimal requirements which should be regarded as sufficient. These were issued successively in three groups : (*a*) recommendations as to General Education, from 1860 onwards ; (*b*) recommendations as to Professional Examinations, from 1861 onwards ; and (*c*) recommendations as to Professional Education from 1867 onwards. By 1874 all the Licensing Bodies demanded Clinical Tests in the qualifying examination.

The effect of the Medical Act (1886)

The second modern major Medical Act was passed in 1886. It authorized five practitioners of medicine to be elected to the Council by the postal votes of the profession as a whole. Later, " direct representatives were able to make a special contribution in cases of 'canvassing for patients' —a matter with which the Council had not begun to concern itself in 1886." It also laid down that applicants for registration were required to have passed Qualifying examinations in Medicine *and* in Surgery *and* in Midwifery. An examination for a " half-qualification " no longer sufficed. In addition, the Council had now a duty to secure the maintenance at Final or Qualifying Examinations of a standard of proficiency " such as sufficiently to guarantee the possession of the knowledge and skill requisite for the efficient practice of Medicine, Surgery and Midwifery." The Council was now empowered to send Inspectors from time to time to report on the " sufficiency " or " insufficiency " of the examinations. The Act required the Council to make a representation to the Privy

327

Council if it appeared to the Council that a Licensing Body was maintaining an insufficient standard of proficiency at its Qualifying Examinations. The Council has continued to issue Recommendations from time to time. These have been " the expression of a concordat amicably reached, not of an ordinance framed and issued by external authority." The constitution of the Council is now one whereby all the Medical Faculties and corporations are represented. The Recommendations of 1922 introduced a five-year curriculum exclusive of Physics and Chemistry ; those of 1936 and 1947 had a tendency to be too precise. Those of 1947 were such that they conveyed an impression that they were really Regulations. The reason for their being worded in such a manner was that vocational training had to be stressed when it was possible for the newly qualified to proceed to independent practice immediately after registration. Students subsequently tended to concentrate on factual data, owing to the growing congestion of the currriculum resulting from the increase of specialism and other causes.

The Dental Profession

" In 1878 the Council was charged by Parliament with the duty of supervising, if not creating, the dental profession." In 1921 the Council was able to hand over its dental functions to the Dental Board of the United Kingdom and published its last Dentists Register in 1922. In 1956 the Dental Board was terminated and on 4th July the General Dental Council came into existence under the Dentists Act (1956).

The effect of the Medical Acts (1950, 1956) and Recommendations (1957)

The more recent Medical Acts of 1950 and 1956 were prepared in close consultation with the Council. The principal provisions in the Act of 1950 affecting medical education were that the newly qualified graduate must in the first place be provisionally registered while he undertakes a year of resident Hospital appointment as a house physician and a house surgeon ; each for a period of six months. If he is then certified by the Licensing Body as having fulfilled these appointments in a satisfactory manner, he will be granted *full* registration and the consequent privileges. This new regulation came into force on 1st January 1953. The hospitals in the United Kingdom in which these appointments can be fulfilled are approved by the Licensing Bodies and not by the Council ; in the Republic of Ireland they are approved by the Medical Registration Council of the Republic. This Act also empowered the Council to send Visitors to Medical Schools as well as to Examinations. In 1952-53 the Council appointed eight persons to act both as Visitors of Medical Schools and as Inspectors or Visitors of Examinations. It was after obtaining reports from the Visitors *and* the observations on them from the Licensing Bodies and Medical Schools, that the Council in May 1957 issued revised Recommendations with reference to the curriculum.

The institution of the pre-registration year adds weight and meaning to one of the new Recommendations which states that " the memorising and reproduction of factual data should not be allowed to interfere with the primary need for fostering the critical study of principles and the development of independent thought " (Recommendations as to the Medical Curriculum p. 10). It will be interesting to know in due course how the teaching Licensing Bodies, which are the Universities, have interpreted this basic definition of education and succeeded in producing a graduate who can be trained subsequently to practise any branch of medicine, one able to think, having the desire to continue learning and the intellectual means to do so. Some Medical Faculties had considered that the Recommendations of 1947 had exerted a restrictive effect on the diversity, freedom of and responsibility for their method of education.

A Faculty of a University should, however, always realise in the words of Sir T. Clifford Allbutt that " the function of a University is *not* qualification for any art or trade but a training of the mind, a formation of habits of study, of insight, of easy handling of ideas and the development of imagination." The new Recommendations " indicate the minimum length of the whole period of professional study, but refrain from specifying the period of time to be allotted to particular subjects or the sequence in which they should be taught. Specialities and subdivisions of the principal subjects are no longer specified, and no attempt has been made to indicate precisely the scope of the instruction which should be given in particular branches " (Recommendations as to the Medical Curriculum, 1957, **1**, 6, para. 10). The method of Education is now therefor the responsibility of the Medical Faculties of the Universities. They can apply the test of the Final Qualifying Examination how and when they wish after the minimum period laid down has elapsed. The Licensing Bodies and Examining Boards holding Final Examinations, of which there are now twenty-three, must, however, each continue to fulfil the duty legally imposed on the Council to be satisfied that their portal of entry into the profession is of a standard " such as sufficiently to guarantee the possession of the knowledge and skill requisite for the efficient practice of medicine, surgery and midwifery." The new Recommendations give the Medical Faculties ample scope to arrange the instruction so that the fragmentation of Medicine is replaced by an integration of all the subjects which may have been restricted by previous Recommendations. The undergraduate should be made to realize that the various subdivisions of Medicine are artificial and the subject is really a one and indivisible whole.

The British Pharmacopoeia

It has already been stated that the profession of the apothecary goes back to antiquity and in consequence the publication of what might be called a Pharmacopoeia was a necessary adjunct to the art of medicine.

In 1585 the College of Physicians, in order to justify their responsib ity with regard to the inspection of drugs, decided to publish a pharmacopo ia, the drafting of which was entrusted to a committee of six Fellows of he College. It was only after a new committee of eight Fellows had been formed, of which William Harvey was one, that in December 1618 the first London Pharmacopoeia was published. Nine subsequent editions were published between 1650 and 1851, the most famous being that of 1836. This one, as it included for the first time the use of alkaloids, " marked an epoch in the history of the science and art of prescribing as it introduced into practical pharmacology in England a new philosophy of the science of Therapeutics."

The Act of 1858 " imposed on the Council the duty of publishing a national Pharmacopoeia containing reliable standards for medicines." The first British Pharmacopoeia was published by the Council in 1864 ; there were four subsequently published by 1914. The purpose of each was " to give authoritative recognition to, and to ensure the purity and conformity to standard of, medicaments used in medical practice." Previously the three Colleges of Physicians had published Pharmacopoeias; those of London from 1618-1851, that of Edinburgh (1699-1841) and of Dublin (1807-1850). The one sponsored by the Council was accepted by all and since then no other Body has issued one. In 1928 a Pharma-copoeia Commission was established which maintains a laboratory and prepares successive editions of the Pharmacopoeia which are then approved by the Council and published.

The Council and the Medical Profession

The Council during the century since its inauguration has truly earned the gratitude of the public and the profession of medicine by the tactful procedures it has adopted to break down the barriers and jealousies which separated the various grades of practitioners. By its most recent Recom-mendations with regard to the Curriculum it has provided the opportunities which have been sought by the teaching Licensing Bodies to enable them to develop medical education by what are regarded as University methods, untrammelled by any restrictive influences. The need for the establish-ment of such a body as the General Medical Council should now be apparent to all and its influence be appreciated on the education and the social status of the medical profession.

REFERENCES

ALLBUTT, Sir T. Clifford (1905) *The Historical Relations of Medicine and Surgery.* Macmillan, London.

BARRETT, C. R. B. (1905) *The History of the Society of Apothecaries of London.* Elliot Stock, London.

CHEMIST AND DRUGGIST (1927) The Beginnings of Pharmacy 1, 797-816.

COPE. Sir Z. (1956) Influence of the Society of Apothecaries upon Medical Education. *Brit. med. J.* **1**, 1.

GENERAL MEDICAL COUNCIL (1957) Recommendations as to Medical Curriculum.

GRAHAM-LITTLE, Sir E. (1939) The History of Medical Education in the last hundred years. *Med. Press* **101**, 110-114.

GRIER, J. (1937) *A History of Pharmacy*. Pharmaceutical Press, London.

MACNALTY, Sir A. (1946) *The Renaissance and its influence on English Medicine*. Christopher Johnson. London.

NEWMAN, C. (1957) *Medical Education in the Nineteenth Century*. Oxford University Press.

NEWMAN, Sir G. (1928) *Linacre's Influence on English Medicine*. Privately printed.

PYKE-LEES, W. (1958) *Centenary of the General Medical Council*.

ROYAL COLLEGE OF SURGEONS OF ENGLAND (1940) Calendar. Historical summary XVII-XXVI.

WITHINGTON, E. T. (1894) *Medical History from the earliest times*. The Scientific Press, London.

APPOINTMENT OF FELLOWS AND MEMBERS
TO CONSULTANT POSTS

W. W. DAVEY, M.D., F.R.C.S.	Professor of Surgery to the University College, Ibadan, Nigeria.
C. ST. J. DAVIES, M.R.C.S., L.R.C.P., D.M.R.D.	Consultant Radiologist to Stockport and Buxton Group of Hospitals.
G. H. WADDINGTON, M.R.C.S., L.R.C.P., D.M.R.D.	Consultant Radiologist, to Bolton and District Group of Hospitals.
J. A. CARR, M.D., F.R.C.S.	Consultant Surgeon to Bury and Rossendale Group of Hospitals.
R. A. DAWS, F.R.C.S.	Consultant Neurosurgeon, based on Preston and Lancaster.
J. R. M. MILLER, M.B., B.S., F.R.C.S.	Surgeon, Nairobi European Hospital.
B. H. HAND, M.S., F.R.C.S.	Consultant Surgeon to Ipswich and East Suffolk Hospital Group.
D. E. SAVAGE, M.B., F.R.C.S., M.R.C.O.G.	Consultant Gynaecologist, Highlands General Hospital.
R. C. FULLER, M.B., F.R.C.S.	Consultant Surgeon, Acton Hospital.
M. D. W. HAMILTON, M.B. F.F.A.R.C.S.	Consultant Anaesthetist, Willesden General Hospital.
G. H. BANCROFT-LIVINGSTON, M.D., F.R.C.S., M.R.C.O.G.	Consultant Obstetrician and Gynaecologist, Luton and Hitchin Group of Hospitals.
D. RANGER, M.D., F.R.C.S.	Consultant E.N.T. Surgeon, Mount Vernon Hospital.
W. E. LEWINGTON, M.B., F.R.C.S. M.R.C.O.G.	Consultant Obstetrician and Gynaecologist, Royal London Homeopathic Hospital.

331

28

SECOND PROVINCIAL MEETING

THE SECOND PROVINCIAL Meeting of the College was held in Cardiff on 27th September, with a Reception and Dinner of Fellows and Members on the preceding evening.

The meeting opened with a Reception, kindly given by the Lord Mayor and Council of the City of Cardiff, at Cardiff Castle. About one hundred and fifty Fellows and Members received invitations for this pleasant occasion.

The Dinner was held at the New Continental Restaurant and 177 Fellows and Members and their guests were present. The toast of the College was proposed by Sir Philip Morris, Vice-Chancellor of the University of Bristol, and replied to by the President. Professor Lambert Rogers proposed the toast of the guests, to which the Lord Mayor of Cardiff and Colonel E. Bland Stokes, Chairman of the Board of Governors of the United Bristol Hospitals, replied. Other guests included the Lady Mayoress, the Bishop of Llandaff, the Lord Lieutenant of Glamorgan, the Chairman of the Board of Governors of the United Cardiff Hospitals, the Chairman of the Welsh Regional Hospital Board, the Presidents of the Royal College of Surgeons of Edinburgh and the Royal Faculty of Physicians and Surgeons of Glasgow and the Provost and members of the staff of the Welsh National School of Medicine.

On the morning of Saturday, 27th September, a programme of scientific films, operations and exhibits had been arranged by members of the profession in Cardiff and Bristol at the Cardiff Royal Infirmary.

The following exhibits were shown :

Some developments in cardiac surgery—R. E. Horton, J. Clutton-Brock.
Management of portal hypertension—R. Milnes Walker.
Intracranial aneurysm. A new method of surgical treatment—J. Dutton and Bristol Neurosurgical Unit.
Disease of the biliary tract and prostatic diseases—J. H. Middlemiss.
Encephalographic monitoring of light anaesthesia—J. Clutton-Brock.
Some abnormalities of the aortic arch and its branches—H. R. S. Harley.
Primary bone forming tumours and their relationship to skeletal growth—C. H. G. Price.
Occupational quiz—G. A. Hodgson.
Hydatid disease in childhood—O. P. Gray.
Staphylococcal cross-infection in surgery—W. A. Gillespie, W. Wypkema, V. G. Alder, G. Ayliffe, J. W. Bradbeer.
Corneal grafts—Sir Tudor Thomas.
Pathology of the spine—J. Gough, E. E. Payne.
Developmental anomalies in the region of the foramen magnum—J. D. Spillane.
Radiological quiz.—Radiology Dept., Cardiff.
The Paterson-Brown Kelly syndrome.—E.N.T. Dept., Cardiff.
Re-surfacing arthritic joints—K. H. Pridie.
The cervical spinal canal in syringomyelia—J. D. Spillane, C. Wells, A. Bligh.
Bristol bladder tumour registry—Ashton Miller.
Caplan's syndrome—W. E. Miall, J. C. Gilson.
Peripheral vascular disease in the upper limb—J. H. Peacock.
Some aspects of the behaviour of melanomata—D. C. Bodenham, O. C. Lloyd.
Fusion of calcaneo-cuboid joint in the treatment of the relapsed club foot—Dillwyn Evans.
Sacral agenesis and its relation to disorders of micturition—R. A. Mogg.

Prototype of a disposable heat-sterilisable oxygenator for a heart-lung machine—M. G. Wilson, Keith Vowles.
Management of advanced carcinoma of the breast—R. V. Cooke, D. Ioan-Jones, Keith Vowles, Peter Monks.
Thyroidectomy—R. V. Cooke, D. Ioan-Jones.
Unusual benign conditions of the colon. Arterio-venous aneurysm—D. H. Jenkins.
The control and testing of dressings autoclaves—V. G. Alder, W. A. Gillespie.
Cervical spine—E. E. Payne, J. D. Spillane.
Operation for cervical spondylosis—Lambert C. Rogers and Surgical Unit, Cardiff.
Spinal tumours—Lambert C. Rogers.
Melanomata—A. S. Aldis and Surgical Unit, Cardiff.
Carpal tunnel syndrome—Lewis Thomas and Surgical Unit, Cardiff.
Apparatus—Surgical Unit, Cardiff.
Two cases of diastematomyelia—Charles Langmaid, A. Bligh.
Cardiff Radiotherapy Centre—Glyn Evans.
Early medical photography—Ralph Marshall.
Intravenous dye injection in the investigation of skin and soft tissue trauma.—Emlyn Lewis.
Transthoracic fusion of the spine and reconstructive procedures in the hand—H. J. Richards.
Microsurgery of the ear—Ear Dept., United Bristol Hospitals.
The morbidity of thyroidectomy—Hilary Wade.

There were over 200 visitors to the exhibits and an excellent fork luncheon was provided for them by the Board of Governors of the United Cardiff Hospitals. After lunch the Annual Meeting of Fellows and Members was held in the Reardon Smith Lecture Theatre. There was an attendance of 94 Fellows and 16 Members at this meeting, at which the President presented the Annual Report of the College, Sir Harry Platt spoke about the College's appeal for funds, Professor Milnes Walker reported on the postgraduate educational activities of the College and Professor Lambert Rogers described the work of the Museum.

Immediately after the meeting, Sir Russell Brain was admitted to the Honorary Fellowship of the College. A citation was delivered by Professor Lambert Rogers in the following terms :

" Mr. President, Members of Council, Fellows and Members of the College :

" Doctor Johnson once remarked to Boswell that the great pleasure in life is the influx of novelty. This is a novel occasion as we are met outside London and we are honouring a physician, himself a distinguished Johnsonian.

" It gives me very great pleasure to present him for the highest honour which is in the power of our College to confer.

" While, as might be expected, the College has over the years so honoured many distinguished surgeons in many parts of the world, few physicians have been elected Honorary Fellows. I find that the late Sir George Newman, Lord Dawson of Penn and Sir Humphrey Rolleston constitute a solitary triumvirate in our Calendar and that until this moment there is no living physician with our Honorary Fellowship.

" This is the first Honorary Fellowship to be presented in Wales and it will interest Welsh people everywhere to know that the first Honorary Fellow of our College was a Prince of Wales. Elected in 1900, he subsequently became King Edward VII.

" Sir Russell Brain is a distinguished graduate of the University of Oxford and an Honorary Fellow of New College, Physician and Neurologist to the London and other hospitals, the immediate past President of the Royal College of

Physicians, poet, philosopher and author. He has made many important con.ri-butions to medicine, literature and neurology, and especially that of the spinal cord, an aspect which has been of particular interest to some of us here in Cardiff, and a theme on which we are shortly to hear him speak.

" In a beautifully worded introduction to a doctor's anthology which appeared first in 1952 he used these words, ' we may all be grateful that so many doctors, whether they have achieved literary fame or not, have written clearly and gracefully, humorously and movingly about the fundamentals of life and their profession.' Few can have done this so well as has Sir Russell himself.

" He is the recipient of many honorary degrees and diplomas and we are proud to have his name on the roll of our honorary graduands for it was some five years ago that the University of Wales made him honorary LL.D.

" I have, therefore, the honour and very great pleasure, Mr. President, of presenting to you, Sir Walter Russell Brain, physician, past president, poet, philosopher and philologist to receive at your hands the Honorary Fellowship of the College."

[Reproduced by courtesy of the *South Wales Echo*.]

Sir Russell Brain with the President and Vice-Presidents after signing the Roll of Honorary Fellows at the Reardon-Smith Lecture Theatre at Cardiff.

In reply Sir Russell Brain spoke of his deep sense of the honour which had been bestowed upon him. He said that much of his work had been carried out in close association with surgeons and mentioned in particular the late Sir Hugh Cairns.

After the ceremony of admission Sir Russell Brain delivered a lecture on " The Cervical Spine."

The whole meeting was an undoubted success, to which the warmth of the sunshine and of the hospitality of the surgeons of Cardiff and Bristol contributed in full measure.

The thanks of the College are due to the Local Committee, under Professor Lambert Rogers' chairmanship, which arranged the programme, and in particular to Mr. A. S. Aldis, the Honorary Secretary, who worked untiringly to ensure that every detail of the arrangements was perfect. The College is also very grateful for gifts and help received from the Boards of Governors of the United Bristol Hospitals and the United Cardiff Hospitals and the Welsh and South Western Regional Hospital Boards.

COLLEGE PUBLICATIONS

READERS ARE REMINDED that the following publications issued or sponsored by the College may be obtained from the Editorial Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2.

Lives of the Fellows, 1930-1951. By the late Sir D'Arcy Power, K.B.E., F.R.C.S., Honorary Librarian, and continued by W. R. Le Fanu, M.A., Librarian. A single volume, bound in blue cloth, of 889 pages, containing the Lives of all Fellows known to have died between 1930 and 1951. £2 2s. 0d. post free.

A Record of the Years from 1901 *to* 1950. Edited by Sir Ernest Finch, M.D., M.S., F.R.C.S. A slim volume, illustrated, containing a brief history of the College between the centenary and the 150th anniversary of the foundation with lives of all the Presidents since 1900, written by special contributors from their personal knowledge. In red cloth 9s. post free or red paper covers 5s. 6d. post free.

John Hunter, a List of his Books. A short-title bibliography of all known editions of John Hunter's books, compiled by the Librarian. Printed at the Cambridge University Press, and bound in green cloth. 2s. 6d. post free.

A Guide to the Hunterian Museum (*Physiological Series*). This gives a brief account of the physiological section of John Hunter's museum, the scope, design and historical value of which is unique. 48 pp. 1s.

A Descriptive and Historical Catalogue of the Darwin Memorial at Down House. Charles Darwin and his family lived at Down House, near Orpington, Kent, for forty-two years and it was here that most of his scientific investigations were made, including his work on the Origin of Species, published in 1859. 33 pp. 1s.

The Portraiture of William Harvey. The Thomas Vicary Lecture for 1948 by Geoffrey Keynes, M.A., M.D., F.R.C.S. With a descriptive catalogue and 33 reproductions of the portraits. £1 5s. 0d.

*William Clift. By Jessie Dobson, B.A., M.Sc., Anatomy Curator. A new biography, fully illustrated, of the first Conservator of the Museum at the College. Published by William Heinemann Medical Books Ltd. Bound in blue cloth ; 144 pages with frontispiece portrait and 31 plates. 8s. 6d. post free.

*A separate cheque for this publication would be appreciated.

PROCEEDINGS OF THE COUNCIL IN OCTOBER

AT A MEETING of the Council on 9th October, with Professor Sir James Paterson Ross, President, in the Chair, Mr. W. A. Mill (St. Thomas's) was admitted to the Court of Examiners.

The Mitchiner Medal was presented to Lt.-Colonel R. H. Robinson by the Director-General of the Army Medical Service (Lt.-General Sir Alexander Drummond).

The Handcock Prize was presented to Mrs. E. M. Cooke of the Royal Free School of Medicine.

Mr. F. R. Jackaman (Queen Elizabeth's School, Barnet and Cambridge University) was admitted as Macloghlin Scholar.

The John Hunter Medal and Triennial Prize were awarded to Dr. L. W. Proger, Pathology Curator, for his devoted services to the Hunterian Museum.

The award of a Mackenzie Mackinnon Research Fellowship to Mr. K. E. D. Shuttleworth was announced.

Arrangements were approved for the celebration next year of the centenary of the institution of the Licence in Dental Surgery.

Diplomas were granted as follows : *Membership* (1) ; *Fellowship* (1) ; *Fellowship in the Faculty of Anaesthetists* (28) ; *Orthodontics* (11).

The following diplomas were granted, jointly with the Royal College of Physicians : *Ophthalmology* (41) ; *Child Health* (95) ; *Tropical Medicine and Hygiene* (54) ; *Physical Medicine* (9) ; *Industrial Health* (1) ; *Public Health* (1) ; *Psychological Medicine* (1) ; and *Anaesthetics* (1).

The following hospitals were recognized under paragraph 23 of the Fellowship Regulations :

HOSPITALS	POSTS RECOGNIZED		
	General (all 6mths. unless otherwise stated)	Casualty (all 6mths.)	Unspecified (all 6mths.)
MAIDSTONE—West Kent General Hospital (Additional)	R.S.O.		
NORTHAMPTON—General Hospital (Additional)			*Para 23 (b) :* Ophth. Regr. (Ophth. S.H.O.)
EDGWARE — General Hospital (Additional)			*Para 23 (c) :* S.H.O. (E.N.T.)
AYLESBURY—Royal Bucks Hospital (Additional)			Acc. and Orth. Regr.
WREXHAM—Wrexham and East Denbighshire War Memorial Hospital (Additional)			S.H.O. (Orth. and Cas.)
BISHOP AUCKLAND—General Hospital	S.H.O.		
MANCHESTER—Wythenshawe Hospital (Redesignation and Additional.	S.H.O.	*Redesignation of* S.H.O. (Cas.) as J.H.M.O. (Cas.)	
WORDSLEY — Wordsley Hospital (Additional)	S.H.O.		
LIVERPOOL—Walton Hospital ..	*Extension of periods of training from 6 mths to 12 mths.* 1 Senr. Regr. 2 Regrs.		
LONDON—National Temperance Hospital (Additional)		Cas. Off.	
BOURNEMOUTH — Royal Victoria Hospital (Additional)		S.H.O. (Orth. and Cas.)	
NAIROBI — King George VI Hospital (Additional)		Cas. Off. (Regr. status)	

BOOKS ADDED TO THE LIBRARY, JULY - SEPTEMBER 1958

Anatomy
GRAY's Anatomy. 32nd edition. 1958.
DE WARDENER. The kidney, an outline of normal and abnormal structure. 1958.

Anthropology
BOULE. Fossil men, translation of 4th French edition. 1957.

Biochemistry
MEHLER. Introduction to enzymology. 1957.
MULLER and O'CONNOR. International symposium on aldosterone. 1958.

Cancer
DAHLIN. Bone tumors, 2276 cases. 1957.
KLINEVA AND ROSKIN. Problems of anti-cancerous antibiotics (in Russian). 1957. Authors' gift.
PAZOUREK. Microscopic survey of uterine cancer (in Russian). 1955. Author's gift.

Cardiology
CIRCULATION. Harvey tercentenary Congress (1957), Proceedings. 1958. Gift of Mr. A. Dickson Wright.

Cytology
ENGSTROM AND FINEAN. Biological ultrastructure. 1958.

Embryology
BONNER. The evolution of development. 1958.
DEBEER. Embryos and ancestors. 3rd edition. 1958.
See also WILLIS, under "Pathology".

Medical Research
Medical Research in the Veterans Administration, U.S.A. 1958. Editors' gift.

Microscopy
VICKERS. Modern methods of microscopy. 1957.

Neurology
CIBA. Symposium on the neurological basis of behaviour, in commemoration of Sherrington. 1958.
GELLHORN. Autonomic imbalance and the hypothalamus. 1958.
HARMAN. Paleoneurologic, neoneurologic, and ontogenetic aspects of brain phylogeny. 1957. (Pamphlet). Gift of American Museum of Natural History.
JEFFERSON. British papers on neurology 1925-43. 2 volumes. A collection of reprints, presented by the British Council Medical Library.

Ophthalmology
STALLARD. Eye surgery. 3rd edition. 1958.

Orthopaedics
ARMSTRONG. Lumbar disc lesions. 2nd edition. 1958. Author's gift.
BOHLER. Treatment of fractures. 5th edition, volume 3. 1958.
WENGER. The spine jack operation for scoliosis. 1957. (Pamphlet.) Author's gift.

Pathology
BOYD. Pathology for the physician. 6th edition of his Pathology of internal diseases. 1958.
SHERLOCK. Diseases of the liver. 2nd edition. 1958.
WILLIS. The borderland of embryology and pathology. 1958.
WRIGHT. Introduction to pathology. 3rd edition. 1958.

Pharmacology
GROLLMAN. Pharmacology and therapeutics. 1952. Gift of Mr. J. Subramanian.

Radiology
SHANKS AND KERLEY. Textbook of X-ray diagnosis. 3rd edition, vols. 1 and 3, 1957-58.

Surgery
BECK. Surgical aspects of thymic tumor in adults.
BLACKBURN AND LAWRIE. Textbook of surgery. 1958.
PATEY. Introduction to surgery. 1958.
ROB AND SMITH. Operative surgery, vol. 8. 1958. Gift of Mr. M. L. Formby (continuation). The publishers, Messrs. Butterworth, have presented another set of this series for the President's office.

Urology
MIRIZZI. Lithiase de la voie biliaire principale. 1957. Gift of Messrs. John Wright and Sons.

337

Mathematics and Statistics

BERNSTEIN. Statistics for medical and biological students. 1952.
FINNEY. Experimental design and its statistical basis. 1955.
GAMOW. One, two, three—infinity. 1957.
HOGBEN. Mathematics for the million. 3rd edition. 1951.
MORONEY. Facts from figures. 3rd edition. 1956.
SAWYER. Mathematician's delight. 1943.

Physics

ALEXANDER. Atomic radiation and life. 1957.

LAPP AND ANDREWS. Nuclear radiation physics. 2nd edition. 1955.

TAYLOR. Measurement of radio-isotopes. 2nd edition. 1957.

Reference books

BISHOP. Bibliography of International Congresses of the Medical Sciences. 1958.
SIMONS. Catalogue of pharmacopoeias and formularies 1493-1957 in the Lloyd Library, Cincinnati. 1958.

Historical texts

SACHETUS. De podagricis et arthriticis morbis. 1586. Gift of Sir Geoffrey Keynes.
TRINCAVELLI. Opera omnia. 3 volumes in 2. 1599. Gift of Sir Stewart Duke-Elder.
HARVEY. De motu cordis (1628) : Italian translation by Loris Premuda. 1957. Publishers' gift.
HARVEY. De circulatione sanguinis (1649) and Letters : English translation by Kenneth J. Franklin. 1958. Translator's gift.
TURGOT. Mémoire sur la manière de conserver les curiosités d'histoire naturelle. 1758.
HUNTER. The animal oeconomy. 1786. Gift of Sir Gordon Gordon-Taylor.
Instructions for vaccination. Philadelphia. 1807. Photostat copy, gift of National Library of Medicine, Washington.
PARIS. Memoir on the physiology of the egg. 1810.
LAWRENCE, SIR WILLIAM, P.R.C.S. Autograph letter, 1832. Gift of County Seely Library, Newport, I.o.W.
DRUITT. Surgeon's vade-mecum. 10th edition. 1870. Gift of Sir Ernest Cowell.
RÖNTGEN AND OTHERS. X-rays (1898, etc.) Alembic Club reprint 1958.
DARTIGUES. L'instrumentation chirurgicale. 1922.
PAVLOV. Selected works. 1955. Gift of Mr. J. Subramanian.
DUNHILL, SIR THOMAS. Collected reprints 1907-1952. Gift of Miss M. Macdonald.

History of Medicine

BIRMINGHAM DENTAL SCHOOL. A collection of papers on its centenary. 1958. Gift of Mr. R. A. Cohen, L.D.S.
COHEN, LORD. The evolution of modern medicine. 1958. (Pamphlet.)
DUFFY. The Rudolph Matas History of Medicine in Louisiana. Volume 1. 1958. Publishers' gift.
EDINBURGH UNIVERSITY. The University Portraits, by D. Talbot Rice and P. McIntyre. Gift of the University.
KEEN. The surgical operations on President Cleveland in 1893. 1917. With autograph letter from Dr. W. W. Keen, Hon.F.R.C.S. Gift of Professor W. Paton.
KEEVIL. Medicine and the Navy. Volume 2. 1958.
MENZIES CAMPBELL. From a trade to a profession ; byways in dental history. 1958. Author's gift.
PREMUDA. Storia dell'Iconografia anatomica. 1957.
SIMON. Chirurgie d'autrefois. 1928.
SQUIRES. The Sudan Medical Service. 1958. Author's gift.

Biography

ARSÈNE D'ARSONVAL 1851-1940 : Chauvois. D'Arsonval. 1941.
RENÉ LERICHE 1879-1955 : Stèle pour René Leriche. 1958. Gift of Sir Gordon Gordon-Taylor.
ANTOINE LOUIS 1723-92 : Bourakhowitch. Contribution à la biobibliographie d'Antoine Louis. 1958. Gift of Professor P. Huard.
ERNEST SACHS. Fifty years of neurosurgery (Autobiography). 1958. Gift of Sir Cecil Wakeley.
D'ARCY WENTWORTH THOMPSON 1860-1948 : R. D. Thompson. The Scholar Naturalist. 1958.
NICOLAAS TULP 1593-1674 : Thijssen. Nicolaas Tulp. 1881.
ANDREAS VESALIUS 1514-64 : Brocas. Contribution à l'étude de la vie et de l'oeuvre d'André Vésale. 1958. Gift of Professor P. Huard.

SURGEONS *SINE SEDE*

SEVERAL TIMES DURING the history of the Surgeons' Company and of the Royal College of Surgeons the placid conduct of their administration has been disturbed by rebuilding programmes. After the severance of the Surgeons from the Barbers in 1745, particular difficulties presented themselves, for the Barbers placed too high a rental on the premises in the Old Bailey for the Surgeons to contemplate using their former meeting place. Plans were proceeding for their new building between Newgate and London Wall, which was still standing, but there was an interval of six years before this was sufficiently complete for the Court of Assistants to transact their business there. But the business of the Company had to be transacted and the Stationers' Company facilitated matters by lending their hall for meetings. This was situated in a small quadrangle on the north side of Ludgate Street. The original building, formerly the residence of John, Duke of Brittany, and purchased by the Company in 1611, was burned in the Fire of London. The new hall was completed in 1670 and here concerts were held on St. Cecilia's Day, at one of which Dryden's " Alexander's Feast " was first performed. In the garden between the hall and St. Martin's Church condemned books were burnt.

But the Stationers' Hall was not always available, apparently, and the Surgeons were often forced to find refuge elsewhere. This they did by resorting to taverns and coffee-houses, especially for the meetings of the Court of Examiners. This was not such a disreputable procedure as it may sound, for these places formed the customary rendezvous for many of the learned societies, as well as providing consulting rooms for physicians and surgeons.

The Examiners met on several occasions at the Mitre Tavern at 39 Fleet Street. The original building here dated from Shakespeare's time but it too was badly damaged in the Fire of London. From 1728 until 1753 it was the meeting place of the Society of Antiquaries and the Royal Society also used it occasionally. It was here in 1733 that Thomas Topham, the Strong Man of Islington, rolled up a pewter dish with his fingers ; and it was the scene of the first meeting of Boswell and Johnson in 1763. This house was demolished in 1829 to make way for extensions to Hoare's Bank. Another tavern used was the Queen's Arms in St. Paul's Churchyard, also a favourite haunt of Dr. Johnson and of David Garrick. Some meetings were held at the Temple Exchange Coffee House which stood next to the Inner Temple Gate. Having devoured the wooden buildings of Fleet Street, the Great Fire stopped here where the brick buildings of the Temple began. This house was used frequently by Oliver Goldsmith and was in existence until about 1810.

From August 1751, however, all meetings of the Surgeons' Company were held in the new hall ; but for some reason not specified, the annual dinner was not held on the premises, the Crown and Anchor Tavern at the upper end of Arundel Street in the Strand being used for many years for this purpose. This too was much favoured by Boswell and Johnson and, in the middle of the next century, formed the headquarters of the Whittington Club of which Dickens, Thackeray, Dion Boucicault and many of their associates were members. The annual dinners of the Surgeons' Company continued regularly until 1790 when, as it appeared that they were a serious drain on the funds, it was decided to discontinue them.

J.D.

339

ANATOMICAL MUSEUM

THE SPECIAL DISPLAYS are temporarily discontinued owing to reorganiza-
tion of the museum.

DIARY FOR NOVEMBER

Tues.	18	3.45	PROF. R. J. LAST—Arnott Demonstration—Joint movements and muscle actions.*
		5.00	DR. W. CAMPBELL—Radiology of the facial bones—I.
		6.15	MR. J. WATSON—Head injuries.
Thur.	20	5.00	DR. H. A. SISSONS—Erasmus Wilson Demonstration—The repair of bone grafts.*
		5.00	DR. W. CAMPBELL—Radiology of the facial bones—II.
		6.15	MR. C. R. McLAUGHLIN—The cleft palate.
Fri.	21	5.00	Board of Faculty of Dental Surgery.
Sat.	22	10.00	Hand Club—Open meeting.
Tues	25	5.00	PROF. R. B. LUCAS—Pathology of oral neoplasms—I.
		6.15	DR. L. FORMAN—Oral manifestations of skin diseases—I.
Wed.	26		First L.D.S. Examination begins.
Thur.	27		D.P.M. Examination (Part I) begins.
		5.00	PROF. P. H. JONES—Hunterian Lecture—Lobectomy and bronchial anastomosis in the surgery of bronchial carcinoma.*
		5.00	PROF. R. B. LUCAS—Pathology of oral neoplasms—II.
		6.15	DR. L. FORMAN—Oral manifestations of skin diseases—II.

DIARY FOR DECEMBER

Tues.	2	5.00	PROF. G. S. M. BOTHA—Hunterian Lecture—The closing mechanism between stomach and oesophagus and its importance in surgery of the gastro-oseophageal junction.*
		5.00	DR. J. C. HOUSTON—Blood diseases in relation to dentistry.
		6.15	MR. V. E. IRELAND—Disorders of the mandibular joint.
Wed.	3		Second L.D.S. Examination begins.
Thur.	4		Pre-Medical Examination, D.L.O. Examination (Part I) and D.P.M. Examination (Part II) begin.
		5.30	SIR STANFORD CADE—Otolaryngology Lecture—Cancer of the tongue.*
		5.00	MR. R. T. PAYNE—Diseases of the salivary glands.
		6.15	DR. M. J. F. McARDLE—Facial pain.
Mon.	8		Basic Sciences Lectures and Demonstrations for Dental Students begin.
Tues.	9	5.00	DR. L. W. PROGER—Erasmus Wilson Demonstration—Aneurysms.*
Wed.	10		Primary F.F.A Examination and D.P.H. Examination begin.
		7.30	Monthly Dinner.
Thur.	11		Date of Election of Fellows to the Board of Anaesthetists announced. First Membership Examination and D.L.O. Examination (Part II) begin.
		2.00	Ordinary Council.
		5.00	SIR ARCHIBALD McINDOE—Bradshaw Lecture—The problem of facial burns.*
Wed.	17	5.00	Board of Faculty of Anaesthetists.
Thur.	18		Basic Sciences Lectures and Demonstrations end.
Fri.	19		Dental Lectures and Clinical Conferences end.
Wed.	24		College closed.
Thur.	25		Christmas Day. College closed.
Fri.	26		College closed.
Sat.	27		College closed.

* Not part of courses.

340

6

370 PERSONAL CASES OF CLEFT LIP AND PALATE

by
J. P. Reidy, F.R.C.S.
Director of Plastic Surgery Department, Stoke Mandeville Hospital; Plastic Surgeon,
Westminster Hospital

I. Classification

SO THAT WE may talk the same language, let us consider first the classification of clefts of lip and palate.

Veau (1931) divided his cases into four groups (Fig. 1).
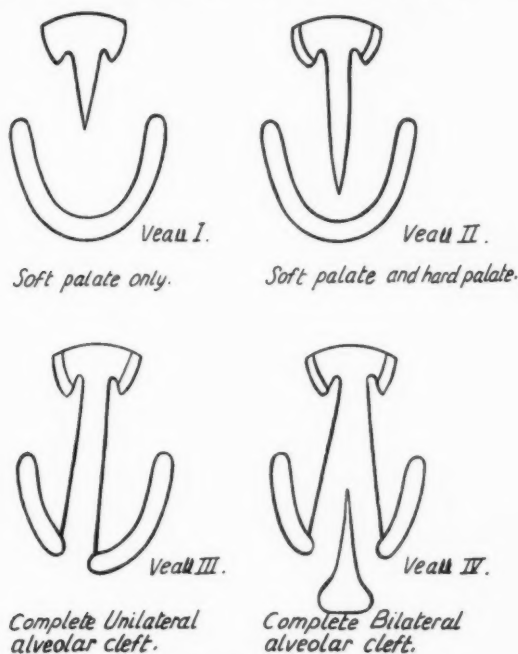
Fig. 1.   Veau's classification of palate clefts.

I.   Cleft of soft palate only.
II. Cleft of soft palate and hard palate to incisive foramen.
III. Complete unilateral alveolar cleft (usually associated with a cleft of lip).
IV. Complete bilateral alveolar cleft (usually associated with bilateral clefts of lip).

No grouping was given for simple clefts of lip.

This grouping seems popular with dental surgeons.

On the other hand, Staige Davis and Ritchie (1922), devised a classification as follows :

Group I. Pre-alveolar clefts
{ unilateral Grp. I.i.
median Grp.I.ii.
bilateral Grp.I.iii. (Fig. 2).

Clefts of soft tissue only.

Gp. 1.i.(R)   Gp. 1.i.(L)

Group one clefts   *Pre-alveolar.*

Gp. 1.ii.   Gp. 1.iii.
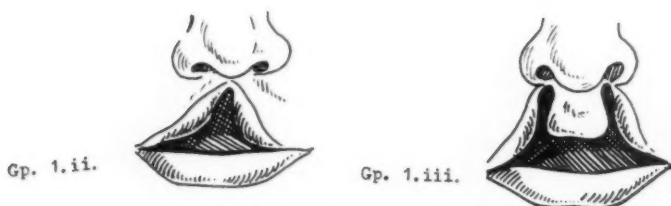
Fig. 2. Group I clefts—pre-alveolar. (Ritchie and Staige Davis).

Group II. Post-alveolar cleft—a median cleft of soft palate : or soft palate plus hard palate. The alveolus is intact. There is also a submucous cleft (Fig. 3).

Group III. Alveolar clefts
{ unilateral Grp. III.i.
bilateral Grp. III.iii.

These are clefts of lip extending through alveolus into palate (Fig. 4).

Note the anomalous anomaly—Grp. III.iii.—*without palate.*

This is a very simple classification, and covers all cleft of lip and/or palate. It is used throughout this paper, and is the most extensively used by those engaged in this type of surgery.

342

Group **II** clefts.   Post Alveolar.

Submucous cleft.
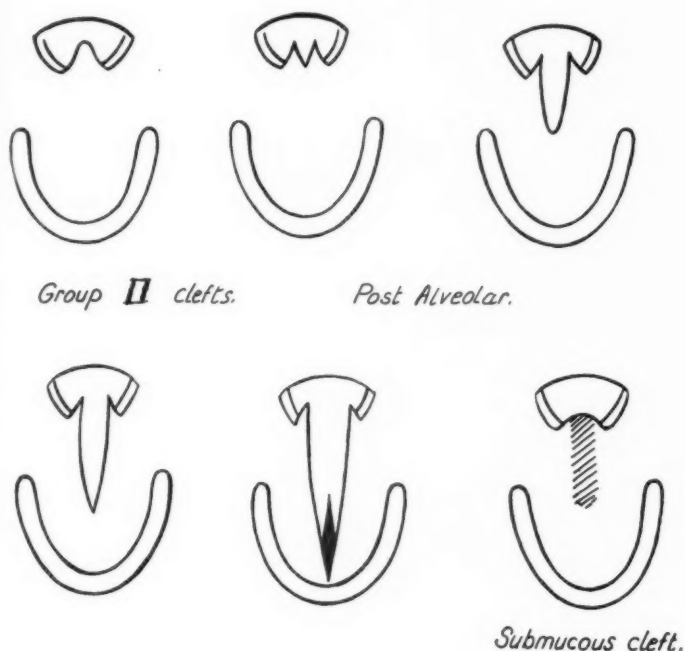
Fig. 3.   Group II clefts—postalveolar (Ritchie and Staige Davis).

II.   Short survey of early palate surgery

As in every other form of study, an appreciation of the past places the present in perspective.

Let us look, therefore, at the work of earlier surgeons on repair of palatal clefts. As the following illustrations will show, early palate surgery commenced by simple paring of the cleft, and suturing the margins together.

Later, an attempt was made to turn tissue into the palate defect as a flap method of repair.

Later still, attempts were made to compress the halves of the upper jaw so as to bring the margins of the palate cleft together the more easily to obtain union.

Exponents of the median suture technique were Von Graefe (1817) and Roux (1819), who simply sutured the edges of the cleft and hoped that union would occur. As a rule, there was great tension on the suture line, and breakdown was inevitable in almost every case.
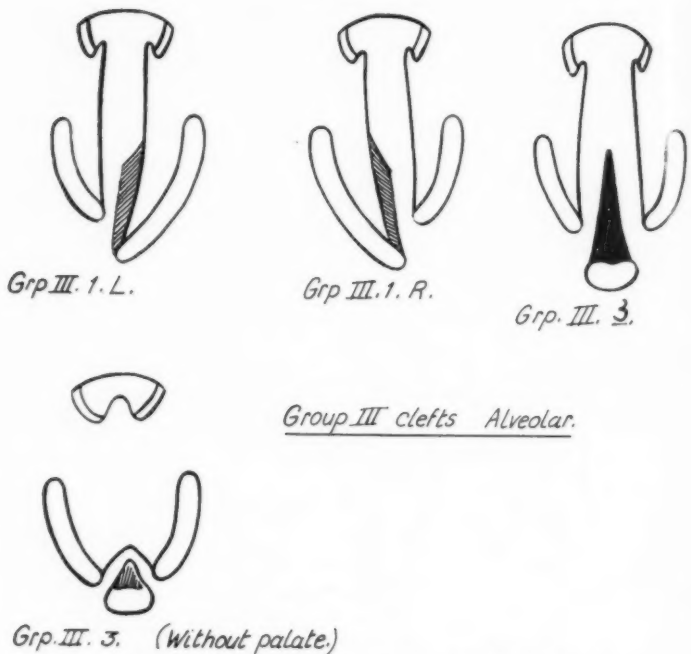
Fig. 4. Group III clefts—alveolar (Ritchie and Staige Davis).

Dieffenbach (1823) and Mettauer (1837) advocated relaxation incisions in the soft palate, which allowed the edges to come together with less tension and therefore less chance of breakdown.

Many other surgeons attempted methods of closure, combining various relaxation incisions, and in 1862 Von Langenbeck wrote a description which may be said to be the first, laying down a series of operative steps, including those of other surgeons, for closure of the palate. In this he advised relaxation incisions along the alveolus and section of the soft palate muscles from the posterior border of the hard palate bones, so that flaps of palatal tissue were loose enough to meet in the midline but still attached in front.

This was a one-layer closure, with a raw area left on the nasal aspect of the soft palate, which healed by scar tissue and therefore resulted in contracture with shortening of the palate.

Surgeons who followed the flap method of closure infolded tissue to close the palate defect, or they transplanted tissue from elsewhere. Flaps were obtained from inside the cheek, from upper lip, and even from

344

the tongue. Von Iselberg went as far as to implant a whole ring finger into the cleft, later amputating the finger from the hand. Krimer (1827) and Arbuthnot Lane (1897), advocated turning over flaps from the surface of the soft palate so that these could be sutured, in the midline, to close the defect. This left a raw surface on that aspect of the palate towards the tongue. A diaphragm was thus formed across the soft palate elements lacking any normal musculature. Davies Colley (1890) followed similiar procedures.

Compression of the maxillae together is always associated with the name of Brophy, who applied mechanical devices to obtain this. In 1923 he advised early compression since the facial bones were more easily moved at an early age. His argument ran that, once the edges have been applied, simple suturing would enable a sound and early union. Grave distortion of the upper jaw accompanied these procedures.

Langenbeck is sometimes called the father of cleft palate surgery, and his name is attached to the operation he described. If Langenbeck is thus noted, then surely Passavant should be known as the father of physiological palatal surgery in that in 1862 he drew attention, for the first time, to the lack of improvement in speech, following operations on the cleft palate. He was the first to point out that the soft palate repairs, in the cases then under review, were so short that they could not possibly reach the posterior pharyngeal wall, and he claimed that this short palate was responsible for the common nasal speech which followed repair of the palate. Passavant attempted to lengthen a palate repaired by the Langenbeck technique, by suturing the posterior pillars of the fauces across the naso-pharynx.

Then he tried suturing the posterior margin of the soft palate to the posterior pharyngeal wall. This apparently gave better results in speech than anything hitherto.

Later, he divided the palate at the level of the junction of hard and soft palate, allowing the soft palate to slide back, so leaving a defect. This defect in the centre of the palate was sometimes closed by a local flap. Even better speech followed this method of treatment, which resembles very much the operation advocated later and now known as the Gillies-Fry technique.

Passavant, not satisfied with his results, used in 1863 a flap of mucosa cut from the posterior pharyngeal wall and folded forwards to make a shelf-like projection towards the soft palate—the first pharyngoplasty.

So many other surgeons have contributed to this branch of surgery that it is impossible to mention all of them. An important step deserves attention, and this was the division of the hamular processes to relax the tensor palati muscles, advocated in 1889 by Billroth.

Of equal importance in 1920, Ganzer divided the palatal flaps in the front so as to allow the whole of the hard palate muco-periosteum and the

345

30

soft palate to slide back, exposing the palate bone in front and producing a raw area on the nasal aspect of the soft palate.

In 1921, Sir Harold Gillies and Kelsey Fry advocated closure of the soft palate at the expense of the hard palate, pushing the soft tissues back, and closing the resulting defect in the hard palate by using an obturator. Dorrance, in 1925, lifted the whole of the hard palate muco-periosteum and lined it with a skin graft. He then allowed the whole lot to slide back so as to relax the soft palate, the cleft of which was closed by suturing. This he called a " push-back operation."

In 1931, Veau published details of his contributions to cleft palate surgery, which were outstanding. First, his speech results were very much better than previous surgeons had obtained : secondly, he allowed the tissues to slide back after dividing the hard palate muco-periosteum in front after the manner of Ganzer : and thirdly, he stressed the two-layer closure of the palate, which so far had only been hinted at by Davies Colley. He insisted on closure of mucosa on the nasal aspect, suture of muscle layer, and then closure of the oral mucosa. Furthermore, he included fracture of the hamular processes, dissection of lateral nasal mucosa from the internal pterygoid processes (thus opening up the Space of Ernst), and the preservation of posterior palatine arteries. This procedure is now known as the V-Y retroposition.

In the early '30s, Kilner used the Langenbeck procedure combined with Wardill's pharyngoplasty. Veau's V-Y technique was then adopted, again with pharyngoplasty until finally—1937—Kilner abandoned the pharyngoplasty, in primary cases in infants, in favour of a more radical technique than that of Veau, ensuring marked V-Y retroposition of the soft palate. All the palatal clefts in this series have been treated on the basis of the V-Y procedure.

Wardill extended the technique by evolving and describing the four-flap repair.

III. Embryology

For our purposes, consideration of growth centres of the face must be brief, and dates from Streeter's 30-32 day-old embryo.

The diagram is simplified, and shows a

Fronto-nasal process which forms sides of nose, middle nose and septum, philtrum and *premaxilla*.

Maxillary processes which form cheeks, upper lips (except philtrum), floor of nose, upper jaw, *palate* (*except premaxilla*).

Mandibular processes which form lower jaw, lower lip.

Between ninth and twelfth week in embryo, all these formations are normally completed.

Streeter (1948) prefers to think not of " processes with free ends," but of centres which proliferate and smooth out furrows under the ectoderm.

346

He does not believe that ectoderm is absorbed between two advancing surfaces. Below the olfactory pits, the premaxillary and maxillary growth centres spread forwards and medially to form the primitive palate. The maxillary centres spread from before backwards, fusing with primitive palate in front, and with each other and with lower edge of nasal septum in the midline. It is generally accepted that the palatal processes from the maxillae do fuse edge to edge, with associated epithelial breakdown, and that the palate is formed by the processes meeting in the midline.

The incisive canal makes the point of juncture between premaxillary and palatal processes.

Cleft formation

In cleft lip, there is failure of union of mesoderm of median nasal growth centre to that of one or both maxillary growth centres, and so the ectoderm breaks down (Veau, 1938 ; Stark, 1954). In cleft palate, the defect is between palatal processes (Grp. II) or between maxillary and nasal growth centres (Grp. III). Here fusion is later than in the lip, and clefts of lip or palate may occur independently.

Aetiology

The aetiology of cleft lip and palate is not clear. Various causes have, in the past, been put forward such as " shock," " frights," mechanical injury during pregnancy, the presence of aminotic bands, and abnormal development of embryonic vessels in the facial processes or centres.

Attention has been drawn to the presence of hydrocephalus in some of these cases, to discrepancies in ages of parents, to inbreeding, to feeding difficulties, and to the state of health of the mother.

The occurrence of such clefts has been noted where the mother has had German measles in the first three months of pregnancy.

Numerous writers, however, state a preference for hereditary disposition. There are numerous early reports of familial occurrence in hare lip and cleft palate, but these are unreliable. It was not until 1878 and later that attempts were made systematically to find an hereditary disposition. This was present in not more than 20 per cent. of the cases, while certain other features began to be apparent. Thus, it was noted that hare lip is more commonly left than right, and more common in males than females, while hare lip plus cleft palate is more common than cleft palate alone, and malformations of the extremities are frequently associated.

More modern workers, Birkenfeld (1926), Eicker (1930), Schroder (1931), Sanders (1934), and others have found familial occurrence ranging from 20 per cent. to 44.6 per cent. The father is usually the direct transmitter (preponderance of sex-linked inheritance), and the malformation generally more severe in the children than in their parents in the case of direct inheritance.

347

Cleft lip and palate occur " naturally " in animals. Experiments in animal feeding, particularly in the withholding of certain amino ac ls, have produced congenital deformities of this nature.

It would appear that in addition to the hereditary factor, and to he virus of German measles, other causes must be considered, including deficiencies in maternal diet in the early months.

Recent work on the clarification of D.N.A. (desoxyribonucleic acid) heralds a most important advance in the understanding of the gene, chromosome and cellular enzyme.

Frequency

Fogh-Anderson (1942) gave a list of frequency of occurrence in different countries. The figures are not exactly comparable since the method and timing of collection vary. Some are made up of reports from lying-in hospitals, and others consider only the figures of those that survive and come to operation.

1864	Frobelius	..	Russia ..	..	118 : 180,000	1 : 1,525
1908	Rischbieth	..	England ..	..	39 : 67,945	1 : 1,742
1924	Davis ..	..	U.S.A. ..	..	24 : 28,085	1 : 1,170
1929	Peron	..	France ..	..	106 : 100,889	1 : 942
1931	Schroder	..	Germany..	..	28 : 34,000	1 : 1,214
1931	Gunther	..	Germany	..	102 : 102,834	1 : 1,000
1934	Sanders	..	Holland	..	16 : 15,270	1 : 954
1934	Grothkopp	..	Germany	..	74 : 47,200	1 : 638
1939	Edberg	..	Sweden ..	..	28 : 27,000	1 : 960
1939	Fogh-Anderson	..	Denmark	..	193 : 128,306	1 : 665

(Fogh-Anderson)

	193 cases (Denmark)	665 cases (Danish Hospital)
Pre-alveolar	32 per cent.	25 per cent.
Post-alveolar	23 per cent.	25 per cent.
Alveolar	45 per cent.	50 per cent.

It is of interest at this point to consider certain statistics in this series, noting the place of the patient in the family and the occurrence of similar defects in the family. This information was not available in every case.

Patients : 370   Males   211   Females   159

Place of patient in family		Similar defect in	
First child	156	Brothers	6
Second child	61	Sisters	9
Third child	37	Mother	2
Fourth child	21	Father	7
Fifth child	8	Mother's brothers	3
Sixth child	10	Mother's sisters	1
Seventh child	4	Father's brothers	1
Eighth child	1	Father's sisters	2
Ninth child	2	Maternal grandparents	10
Tenth child	1	Paternal grandparents	8
After tenth	2	Maternal cousins	9
		Paternal cousins	5

348

Anatomy

The soft palate normally moves up and down, and can be tensed. In normal speech and swallowing, it can be opposed to the posterior wall of the pharynx, and to the lateral walls which move medially.

The levator muscle elevates the palate, and the superior constrictor narrows the pharynx from side to side. These two muscles work together to close nose from mouth, an essential for normal speech, normal swallowing, and for raising the air pressure within the mouth.

When the soft palate fails to meet the posterior pharyngeal wall, there is palato-pharyngeal incompetence.

The cause of palato-pharyngeal incompetence may lie in the condition, length, and movement or paralysis of the soft palate, or in the shape and size of the pharynx, or both.

Passavant (1869) described a ridge on the posterior pharyngeal wall, occurring during speech in a patient with a cleft palate. He considered this was present in normal palato-pharyngeal closure, but visible only where the palate was cleft. He also concluded that the ridge was caused by the upper border of the superior constrictor muscle. Others have since contended that the ridge is formed by the horizontal fibres of palato-pharyngeus muscle.

Veau (1943) claimed that this ridge has nothing to do with speech. Calnan (1957) lists many observers, including himself, who state that though the ridge can be seen in patients with cleft palate, it is nevertheless not essential for speech since it is seen in a few, is easily fatigued, and is too low in level.

The ridge appears to be related to an effort to close the naso-pharyngeal opening in blowing rather than in speech.

IV. Criteria—methods and technique

Professor Kilner has more than once remarked that the objectives of surgery of the lip and palate are—to make the patient look well, feed well, and speak well.

The following criteria apply to all infants and young children about to undergo surgical treatment.

Prior to operation the child shall have been gaining weight steadily, i.e., no feeding difficulties ; the haemoglobin shall not be less than 80 per cent. ; swabs from nose and throat shall be free of Beta-haemolytic streptococci ; the child shall be free of intercurrent disease.

It is time, I believe, to say that the rather mysterious figure, the 10lb. child, should disappear. For too long, this well fed individual has governed the approach to surgery in children. Dickens makes one of his characters relate " there ain't no sich person " and I would apply that remark to the 10lb. child. An infant may be 10lb. at birth or may not achieve that weight for several months. The actual weight, therefore, is not a reliable yardstick by which operation should or should not be attempted.

349

Optimum age for operation

Veau (1931) showed that the earlier the palate is repaired the be er the speech results. His results of operation under one year and at one to two years showed 70 per cent. normal speech, whereas the percentage decreased rapidly as the age at operation increased.

He also showed in his 1929 figures a mortality of 3.8 per cent. (nineteen cases) in operation under four years. Of these the highest mortality occurred in cases operated upon under one year of age.

His 1933 figures show considerable reduction in mortality, but still very much higher under one year than when operation is performed later. Veau, therefore, preferred to operate at about two years of age, on palates.

In this series, in the primary cases in infants, the teaching of Professor Kilner has been followed.

In Group I (pre-alveolar) clefts, cosmesis only is desired, and operation has been undertaken between six and nine months.

In Group II (post-alveolar) clefts, the problem is to provide a mobile palate of adequate length to close nose from mouth. The date of choice is on or about the first birthday. The child is old enough to stand the operation, and has as yet only a few words of speech.

Speech development after operation should follow that of a normal child.

In this series, 134 palates were repaired at one year of age.

Where palatal repair has taken place in older children and in adults, the need for speech training is paramount over many months or years,

In the Group III (alveolar) clefts, the problem is threefold—feeding, speech, and cosmesis, in that order. The repair of lip and anterior hard palate takes place at eight to twelve weeks, taking one side at a time in the bilateral cases. At one year, the palate is repaired.

TECHNIQUE

Group I clefts

At operation, usually between six and nine months, under general anaesthesia, the simplest procedure has been followed, that of Rose's excision, bowing medial and lateral margins of the cleft to gain required length. On few occasions, the le Mesurier technique has been followed.

It will be noted that a characteristic of this cleft is that the nostrils are symmetrical, even though the nostril floor is broad. Asymmetry of a nostril is present only where the alveolus is notched, grooved or cleft, and such a case properly belongs to Group III.

A continuous nylon suture in muscle leads to less reaction and contracture than catgut. The final scar line is single and straight through and through, and thus easier to deal with technically, if and when secondary

work is required. A common fault is the appearance of excess of mucosa in the upper lip lateral to the lip scar.

Group III clefts

In the unilateral cleft, the lip and the anterior hard palate are repaired at the first operation between the eighth and twelfth week.

Usually there is a gap in the alveolus due to the forward rotation of the premaxilla, and the nostril on that side is stretched out horizontally. The lip repair, therefore, is made across this gap, sometimes of nearly half-an-inch, and thus the lip elements may be sutured under some tension at operation.

The anterior palate is closed using mucosal flaps, vomerine and lateral nasal, in one layer only. Since 1948, I have not used the anterior palatal flap (Veau) because of the risk of breakdown, just in front of that flap, which leaves a fistula extremely difficult to close. Where the single layer repair by mucosal flaps persists, this is rapidly covered on its raw surface by spread of epithelium to give, in effect, two layer closure. If the mucosal flaps separate, they return to their original sites without loss, and can be used again in a four-flap repair at one year.

Great store is set by some surgeons in attempting at this first operation, reproduce a nostril margin matching the normal, and in endeavouring to obtain a final lip repair. In this series, the simplest anatomical replacement has been followed, and it is interesting to note that, so often in these Group III repairs, what looks ugly at the end of operation improves in succeeding weeks to something more pleasing. The reverse also holds.

In the bilateral clefts, the same procedure is followed, taking the second side three to four weeks after the first.

No attempt has been made in any of these cases to retropose the premaxilla by forcible manual replacement, or by excision of tissue behind the premaxilla and pinning the premaxilla back into place.

In those cases where the alveolus is notched or fissured without rotation, the lip repair is much easier, and in bilateral cases both sides may be done at one operation. The anterior palate is left for closure at one year.

Several things follow the lip repair. There is moulding of the premaxilla into better position by the band of lip muscle. The attachment of lip elements (in the bilateral cleft) to the prolabium stimulates a notable development of this in size, which is of great value in secondary procedures. And lastly, the repair of the lip converts the case technically from a Group III to a Group II. The rules for Group II clefts operate, and these can now be considered.

Group II clefts

These are midline clefts of palate which extend forwards from the uvula towards the incisive foramen. They may be confined to soft palate

351

J. P. REIDY

only, or include the hard palate as well. They usually occur in thirds of the soft palate, and thirds of the hard palate.

Where the soft palate only is cleft, the septum is not visible, and is attached to the hard palate. Where the hard palate is also cleft, the septum is revealed, and may be low enough for its mucosa to be included in the repair.

Operation is performed, by choice at one year, under general anaesthesia.

In this series, the operation is that of the V-Y retroposition, based on that of Veau and Kilner.

This procedure can be applied to all clefts of the soft palate, and also to those where the cleft includes about one-third of the hard palate. Where the cleft is through soft palate and hard palate, the four-flap repair, described by Wardill, has been undertaken. Some writers lay great stress on repair of the palate by a three-flap or four-flap method. The principles are, in fact, the same as the V-Y procedure, which is that of two-layer closure of the defect. The use of an extra flap or flaps is purely a technical expedient.

The steps are as follows : once the child has been towelled up, a Shadwell pattern gag is inserted so that the tongue depressor holds the intratracheal tube firmly on to the centre of the tongue in the midline. The patient on the table is tilted so that the head lies, so to speak, in the surgeon's lap. The light is directly overhead, and the assistant stands on the right of the patient and uses the suction tube.

Local anaesthesia with some adrenalin is used in order to obtain haemostatic effect. The edges of the soft palate are pared. An incision is made over each hamular process, and this is infractured in order to release the tensor palati muscle. This incision over the hamulus is extended forwards just within the alveolar margin as far as is necessary and then an incision is carried from the apex of the palate cleft forwards and outwards to meet the alveolar incision. This is clearer on the diagram. The palatal flap thus outlined is lifted by blunt dissection from the hard palate so that the hard palate bone is exposed together with the posterior palatine artery, which appears at the posterior edge close to the alveolus. This artery is preserved. Blunt dissection in the hamular region moves the tissues inward and thus strips them off the internal pterygoid plate, exposing this plate and laying open what is known as the Space of Ernst. The muscles of the soft palate are now separated from the posterior margin of the hard palate, and the dissection is carried forwards on the nasal aspect of the hard palate bones so as to free the nasal mucosa. The effect of this freeing all round is to allow the soft palate elements to slide back towards the posterior pharyngeal wall, and also to be mobile enough to meet together without tension in the midline.

The palate is now repaired in layers. The nasal layer is closed from before backwards, using muco-muscular sutures of 2/O or 3/O chromic

352

catgut, the knots of which are tied so as to lie on the nasal layer of the palate. When the uvula is reached, plastasutes are inserted, since this is composed entirely of mucosa. The oral aspect of the palate is now closed from behind forwards using mattress sutures picking up mucosa. Attention is drawn to the insertion of what is known as an "A" stitch, which comes through the nasal layer of the mucosa and then through the palatal flaps, and this stitch, when tied, holds these two layers together and so prevents the formation of a dead space. It is inserted at junction of hard and soft palate.

At the end of operation, the spaces of Ernst produced by dissection of tissues from the internal pterygoid plates are packed with iodoform gauze, which remains for seven days, and a tongue stitch is inserted so that a good airway can be maintained, if necessary.

As the operation ends, the anaesthetist brings the child to a more shallow level, and the child should be crying on the table before leaving the theatre. Movements of the palate can be observed during this process before the gag is removed.

This is the basis of the V-Y procedure. If the four-flap repair is required, it merely means that the dissection of the nasal mucosa is extended forwards to the apex of the cleft, and the palatal mucosa is lifted in two triangles based on the alveolus in front which provide the two extra flaps, thus making four. The principle remains the same.

Post-operative regime

The child returns to the ward lying on its side, with a tongue stitch in place. When conscious, the child is given about 2oz. of saline by mouth, with the addition of a drachm of brandy.

Two hours later, a further 2oz. of saline are given, and two hours after that normal feeding is resumed. The tongue stitch is removed as soon as the child is fully conscious and able to swallow normally.

The iodoform packs are removed on the seventh day in the ward by simple traction backwards and downwards. No sedative is required. On occasion, about the fifth day, a slight temperature may be noted on the chart, and it is customary to remove the packs on the fifth day if this occurs, rather than wait until the seventh. In most cases, the temperature then subsides.

The effect of moving flaps of palatal muco-periosteum medially is to leave areas of exposed palate bone just within the alveolar margins. These areas are covered by spreading epithelium during the fourteen days following operation. Whatever scar tissue may also form is over the bony surface and, therefore, the degree of contracture is minimal.

The child, after palate repair, is reviewed every year to check speech progress, starting about the second birthday.

Group III.i cases (unilateral) return for trimming of the lip and nostril margins during the fourth year, so that their appearance is improved

and more like the normal by the time they go to school. This trimming
is usually directed towards inrolling of the nostril margin, narrowing of
the nostril floor, and reconstitution of the Cupid's bow of the affected
side, together with removal of some excess of mucosa in the vermilion of
that side. The nose in these unilateral cases very often requires straighten-
ing of the bony bridge and of the septal cartilage in later years as and when
the deformity becomes obvious. It is not the purpose of this paper to
dwell on such secondary deformities.

In Group III iii (bilateral) cases secondary repair of the lip is post-
poned until the seventh or eighth year, as a rule, depending much on the
premaxilla. In these bilateral cases, the premaxilla, if still projecting,
holds the lip forwards and encourages the development of the lateral lip
elements and also of the prolabium. At the same time, the nose tip is
downdrawn, and the facial profile is, therefore, abnormal. The pressure
of the lip on the premaxilla tends to mould this back into a better position
between the alveolar elements. This does not mean to say that a perfect
position is attained in all cases. No attempt is made at primary operation
either to thumb the premaxilla back into position or to remove cartilage
from behind the premaxilla in order to allow this to be put back between
the alveolar elements, to which they may be wired.

The decision to keep or to discard the premaxilla is one taken on the
advice of the dental surgeon, and the tendency now is to retain the pre-
maxilla at least until adult life.

Where the nose tip is downdrawn, mobilization of the prolabium (or
part of it) and the columella allows the nose tip to be advanced to give a
better profile. At the same operation, the lateral elements of the lip
are brought to better position at the sides of the prolabium, with union
of the mucosa below the prolabium.

In the few cases where the premaxilla has been removed about the
seventh or eighth year, a denture holding upper incisor teeth has been
provided.

In very few cases, repair of the Group III.iii lip has resulted in undue
tightness and retroposition of the upper lip. Reference will be made
later to the Abbé flap procedure whereby a portion of full thickness lower
lip is transposed into the upper lip to restore the fullness.

Dental problems

Following repair of the Group II (post-alveolar) cleft there have been
few cases of disturbance of alveolar arch. However, three cases of
alveolar collapse have occurred in this series, where very wide clefts
have been repaired in two stages. The first stage, at about 10 months,
has involved closure of the anterior palate using long Veau flaps, followed,
two to three months later, by the usual V-Y retroposition. Some alveolar
collapse was evident in each case.

The greatest collapse of the alveolus follows repair of unilateral and bilateral (Group III) alveolar clefts. Some dental surgeons point out this collapse as due to fibrosis over the hard palate following repair and to diminution of maxillary growth by interference with blood supply.

There has been need, therefore, for orthodontia, when the permanent teeth erupt, in order to correct the alveolar deformity, so much so that some dental surgeons in England, and many in the U.S.A., suggest that palate repair should be postponed to the fifth or sixth year of life, by which time most maxillary development has occurred, and thus post-operative alveolar deformity will be minimal.

This advice is reinforced by speech therapists, chiefly in U.S.A., who claim that they can eradicate by speech therapy all the defects of cleft palate speech which will have developed between the second year and year of operation.

I do not agree with these contentions. I believe that a defect of speech

(a)　　　　　　　　(b)

Fig. 5.　Group III, 1, L. : (a) Deformed alveolar arch—before moulding ; (b) Alveolar arch after dental moulding, and before lip repair.
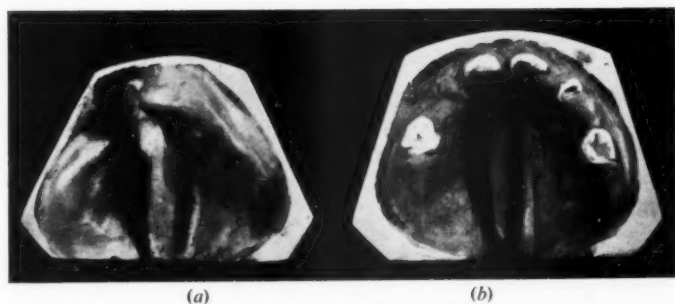

(a)　　　　　　　　(b)

Fig. 6.　Group III, 1, R. : (a) Alveolar deformity—before correction ; (b) Alveolar arch—after correction and lip repair.

is a far greater deformity than alveolar collapse, and therefore product on of good speech by repair of the palate at one year is preferable to operat on at fifth or sixth year in order to get less alveolar deformity. The longe a child has spoken with cleft palate speech defects, the longer time will be required by speech therapy to eradicate these imperfections. There may also have arisen the other problems associated with cleft palate speech which may need the services of a child psychiatrist.

However, I do not now believe that the choice must lie between early operation and alveolar collapse on the one hand, or late operation and

(a)   (b)

Fig. 7. Arches and premaxilla (a) before correction ; (b) after correction and repair of left lip cleft.

speech therapy on the other. The recent work of Kerr McNeill (Glasgow) has opened up a new conception—that of orthopaedic restoration of the alveolar arch *before any* surgical treatment : Burstom (Liverpool) working on Osborne's (Liverpool) cases, and influenced by some of the work of McNeill, has also shown that the projecting premaxilla can be rapidly moulded into good alignment plus the expansion of lateral arch elements before the lip repair is performed at two to three months. This can be done with more certainty in unilateral than in bilateral cases (Figs. 5, 6 and 7.)

It has also been claimed that, following palatal repair at an early age, the development of the maxillae lags behind the unhindered growth of the naso-pharynx, and therefore palato-pharyngeal function, normal immediately after operation, will become inefficient later and give rise to renewed difficulties of speech. If this is so, follow-up of post-operative results should reveal progressive deterioration in speech after the fifth year of age, by which time some five-sixths of total maxillary growth has occurred.

Conversely, if the palate is not to be repaired until the fifth or sixth year, there must surely be some lack of development by disuse of the palatal muscles so that ultimate function will be diminished. It has

al o been observed that, in those cases where palate repair has not been performed or has failed, the pharynx is abnormally capacious. I believe, therefore, that the advantage lies in early repair of palate, which by its muscular action helps to coordinate growth of the naso-pharynx to its own pace. Furthermore, speech results over several years of follow-up do not show deterioration.

Lastly, the development of neuro-muscular pattern of articulation will be firmly established by the sixth to seventh year and, if faulty (because of the presence of a palate cleft), will require much time and effort to correct *after* the palate has been repaired at this late age.

V. Pharyngoplasty

This is a procedure designed to reduce the dimensions of the pharynx.

Passavant (1862 and 1863) appears to have been the first to have stressed the need for contact of palate with posterior pharyngeal wall in speech. He sutured the palate to the posterior pharyngeal wall, with some improvement in speech. He then folded a flap of posterior pharyngeal wall mucosa to form a ridge, but this failed to persist.

Wardill (1928 and 1933) considered that the pharynx in the cleft palate was increased, above normal, from side to side and from front to back. He devised his pharyngoplasty, which consists of a transverse incision on the posterior pharyngeal wall at the atlas arch. After wide undermining, suture of the incision from side to side produced closure in a vertical line, thus reducing the circumference of the pharynx.

It was common practice in the 1930s to combine this procedure with the Langenbeck operation or with the V-Y retroposition in primary cases to give the accompanying palatal repair better mechanical advantage. Kilner discarded the pharyngoplasty and relied on his more radical V-Y operation.

Rosenthal described the use of a flap, based up or down, from the posterior pharyngeal wall, for attachment to the free border of the palate. This reduced the naso-pharyngeal opening, leaving a passage on each side of the flap. The flap tends to tube itself and to become narrow.

Hynes (1950) developed a pharyngoplasty by transplant of muco-muscular flaps (salpingo-pharyngeus muscle) from the vertical to the horizontal. The flaps, taken from the lateral pharyngeal walls, are implanted on the posterior pharyngeal wall above the level of the arch of the atlas. Closure of the lateral pharyngeal defects narrows the pharynx very satisfactorily. The transposed flaps overlap and project as a bulky ridge, in which movement has been demonstrated in a few cases.

In this series, the Wardill pharyngoplasty has been used only in a few secondary cases, and has since been discarded.

The Rosenthal flap has, perhaps, a use where the palate is rigid, but this, too, has been used but little in this series.

357

The Hynes pharyngoplasty is, in my experience, the most useful, nd is the operation of choice in secondary cases.

VI. Investigations of naso-pharyngeal sphincter

Primary cases

(*a*) *Following repair of cleft palate at one year*, the patients have been reviewed at yearly intervals in order to check progress of speech development, and to estimate final success.

At the second and third years, there will be a small vocabulary, some baby talk, and little cooperation. Eventually, the child will repeat words and name objects.

Such words are named :

Tommy Daddy Penny Betty Feather Very Good Catch Sixpence
  T   D   P   B   F   V   G   K   S

The patient will reply, and thus articulation will be checked, and nasality (particularly on S), will be revealed if there is nasal escape, indicating palato-pharyngeal incompetence. Blowing up and sustaining a column of water (Windsor measure), and blowing out a carnival blower, are also checks on palato-pharyngeal competence.

Where speech is developing normally, the practice has been not to refer such a case for speech therapy, but to wait until aged four or five years. By this age, most cases have been found to speak normally, and no further action has been necessary.

It has been a source of annoyance, however, to find, on reviewing cases, that some have been referred to speech therapists by the ill-judgment of schoolteachers, dental surgeons, welfare officers, and district nurses, without reference to the surgeon concerned, and indeed often where the need is not present.

Hynes has pointed out that some of the words used comprise several sounds, and require several structures for production, e.g., lips, tip of tongue, hard palate, back of tongue, and palato-pharyngeal sphincter. He therefore recommends using the vowel Ah, an unspecialised vowel produced by opening the mouth and depressing the tongue to the floor of the mouth. He then combines different consonants to the Ah (e.g., Tah, Dah, Gah, Kah), so that each consonant is uncomplicated and its sound easily detected.

Production of a certain consonant in isolation does not mean ability to produce the same consonant in continuous speech. However, as Hynes points out, the correct production in isolation does reveal the presence of the apparatus to produce that sound, and this may indicate the need for speech therapy alone. Conversely, inability to produce the correct sound in isolation shows the absence of the necessary apparatus, and reveals where the fault lies.

Hynes' method of testing is of great value in these cases where speech is developing slowly and with defects, and indicates where speech therapy is worth while.

(*b*) In those cases where previous treatment has failed, the patient may present for investigation of defective speech at any age from five years to sixty years. These are the secondary cases.

The problems here are :

i. To estimate the patient's general ability to speak, and to check articulation in speech by testing word production.

ii. To determine palato-pharyngeal incompetence or not, by using the Windsor measure and carnival blower.

iii. To examine the palate clinically, and to check any defects, its length and movements in relation to the posterior pharyngeal wall.

iv. To try to estimate (chiefly a clinical guess), the size and shape of the naso-pharynx.

i, ii, and iii merely repeat what has already been described following primary repair of palate in infancy. The patient's general intelligence, hearing and vision are noted, and the patient is asked to repeat the usual words described above to check articulation.

Nasal escape, if present, will be demonstrated when the patient says " sing a song of sixpence."

Hynes has stated that abnormal tongue movements are the commonest causes of bad speech, and his tests using Tah, Dah, Gah, Kah, will reveal whether the tongue is at fault.

Normally, the tongue tip rises on saying " Lah," Tah," " Dah ," and the back of the tongue rises on saying " Kah," " Gah," " Ah-ay-ah." Palato-pharyngeal incompetence and faulty tongue movements may be present together or separately.

iv requires investigation of the naso-pharynx by using lateral X-rays and an opaque medium as described by Calnan (1956). Lateral X-rays, taken with the palate at rest, saying Ee, and blowing, will give much information, as follows (Calnan, 1956) :

(*a*) Length and mobility of the soft palate.

(*b*) Presence of an adenoid pad.

(*c*) Size and shape of the naso-pharynx.

(*d*) Competence of the naso-pharyngeal closure.

(*e*) Confirmation of results of surgery and/or speech therapy. (Fig. 8, c,d : AB).

(*f*) Need for speech therapy (Fig. 8, AB) or further surgery (Fig. 8, e,f).

One should note that adenoidectomy is not lightly to be undertaken in cases of repaired palate. It has been known that speech deteriorates after such an operation for several months, much to the alarm and distress of all concerned. Speech therapy is helpful in these cases.

WESTMINSTER HOSPITAL

PLASTIC SURGERY I

NAME					HOSPITAL NUMBER	1	2	3	4	5	6
(To be written on Punch Card)								7	8	9	
ADDRESS				LOCALITY OF RESIDENCE			10	11	12	13	

		14	15	16	17	18		19	20		21	22
						SERIES NUMBER						
DATE OF BIRTH						FATHER'S AGE				MOTHER'S AGE		

23	SEX					
MALE	...	...	...	...	1
FEMALE	...	...	...	...	2

24	PLACE IN FAMILY					
1st CHILD	...	...	...	...	1
2nd "	...	...	...	...	2
3rd "	...	...	...	...	3
4th "	...	...	...	...	4
5th "	...	...	...	...	5
6th "	...	...	...	...	6
7th "	...	...	...	...	7
8th "	...	...	...	...	8
9th "	...	...	...	...	9
10th "	...	...	...	...	10
AFTER 10th	...	...	...	...	X

25	ILLNESS OR ACCIDENT DURING EARLY PREGNANCY			
DURING 1st MONTH	...	...	1
DURING 2nd "	...	...	2
DURING 3rd "	...	...	3

26	SIMILAR DEFECT IN:—			
BROTHERS	...	...	...	1
SISTERS	...	...	...	2
MOTHER	...	...	...	3
FATHER	...	...	...	4
MOTHER'S BROTHERS	...	...	5
" SISTERS	...	...	6
FATHER'S BROTHERS	...	...	7
" SISTERS	...	...	8
MATERNAL GRANDPARENTS	...	9
MATERNAL GRANDPARENTS	...	10
MATERNAL COUSINS	...	...	X
PATERNAL COUSINS	...	...	Y
SIBLINGS	...	...	1 & 2

27	OTHER CONGENITAL DEFECTS			
CONGENITAL HEARTS	...	...	1
MONGOLISM	...	...	...	2
MICROGNATHIA	...	...	3
TREACHER COLLINS	...	...	4
SYNDACTYLY	...	...	...	5
NASOLABIAL CLEFT	...	...	6
MENTAL DEFICIENCY	...	...	7
ORTHOPAEDIC	...	...	...	8

28	DEATH			
BEFORE OPERATION	...	...	1
AT OPERATION	...	...	2
AFTER OPERATION (Other Causes)	...	...	3

29	C.L. GROUP I			
PRIMARY	...	...	...	1
SECONDARY	...	...	...	2
UNILATERAL (R.)	...	...	3
(L.)	...	...	4
COMPLETE	...	...	...	5
INCOMPLETE	...	...	...	6
BILATERAL	...	...	...	7
MEDIAN	...	...	...	8
NOTCHING OF ALVEOLUS	...	0

30	C.P. GROUP II CLEFT			
SOFT PALATE	...	...	1
HARD PALATE	...	...	2
SUBMUCOUS	...	...	3
CONGENITAL SHORT PALATE	...	4
CONGENITAL LARGE PHARYNX	...	5
PRIMARY	...	...	...	6
SECONDARY	...	...	...	7
FISTULA PRESENT	...	...	8
FISTULA REPAIR	...	...	9

31	PHARYNGOPLASTY			
FOR SHORT PALATE	...	...	1
FOR CAPACIOUS PHARYNX	...	2
TYPE:— WARDILL	...	...	3
ROSENTHAL	...	...	4
HYNES	...	...	5
IMPLANTATION	...	6
PASSAVANTS RIDGE PRESENT	...	7
LATERAL X-RAYS	...	...	8
IMMOBILE POST-PHAR-WALL	...	9

	PHARYNGOPLASTY			
AGE AT OPERATION	32	33	

	PALATE REPAIR			
AGE AT OPERATION	34	35	

36	PALATE REPAIR			
ANT VEAU FLAPS (R & L)	...	1
VEAU FLAP & MUCOSAL FLAP	...	2
MUCOSAL FLAPS ALONE	...	3
REMOVAL HORIZONTAL VOMERINE SPUR	4
V-Y RETROPOSITION	...	5
4-FLAP REPAIR	...	...	6
GILLIES FRY	...	...	7
DORRANCE	...	...	8
TUBED FLAP	...	...	9
BONE FLAP	...	...	0
LANGENBECK	...	...	X
REPAIR OF M-P FISTULA	...	Y

37	C.L. & P. GROUP III			
UNILATERAL (III. I. R.)	...	1
(III. I. L.)	...	2
BILATERAL (III. - iii)	...	3
without palate (III. - iii)	...	4
PRIMARY	...	...	...	5
SECONDARY	...	...	...	6
WITH S.P. CLEFT ONLY	...	7
WITH SUBMUCOUS C.P.	...	8
MIXED	...	...	...	9

38	PREMAXILLA			
MARKED PROTRUSION	...	1
MODERATE	...	...	2
GOOD POSITION	...	...	3
RESECTION OF BONE (PRE-VOMERINE)	4
FRACTURE OF BONE	...	5
ORTHOPÆDIC REPOSTION (KERR McNEILL)	6
ORTHODONTIC REPOSITION	...	7
BONY FUSION BY B.G.	...	8

39	OTHER PROCEDURES			
C.B. PROCEDURE	...	...	1
UPPER EPITHELIAL INLAY	...	2
ABBE FLAP	...	...	3
Z-PLASTY TO VESTIBULAR FOLDS	...	4
NARROWING OF NOSTRIL FLOOR	5
W.G. TO UPPER LIP	...	6

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Fig. 9.   Pre-prepared transcript sheet used for taking case histories.

40	BASIC PROCEDURES				
SKIN W.G.	...	...	...	...	1
T.G.	...	...	...	...	2
FLAP	...	...	...	...	3
GRAFTS: BONE	...	...	...	...	4
CARTILAGE	...	...	...	...	5
FASCIA	...	...	...	...	6
FAT	...	...	...	...	7
PLASTIC	...	...	...	...	8
HOMOGENOUS	...	...	...	...	9
AUTOGENOUS	...	...	...	...	O
HETEROGENOUS	...	...	...	...	X

41	LIP RESULTS				
GOOD	...	...	...	...	1
FAIR	...	...	...	...	2
POOR	...	...	...	...	3
KELOID	...	...	...	...	4
BREAKDOWN OF SUTURE LINE		...		...	5
X-RAY THERAPY	...	...	...		6

42	PALATE RESULTS				
ANATOMICAL (long)	...		...	...	1
MOVES WELL	...		...	...	2
MOVES POORLY	...		...	...	3
IMMOBILE	...	...	...	...	4
SHORT	...	...	...	...	5
FISTULA	...	...	...	...	6

43	NOSE DEFORMITY			
OBLIQUE BONY BRIDGE	...		...	1
SEPTAL DEFORMITY		...	...	2
BONY SPUR	...		...	3
DROOPING NOSTRIL MARGIN		...	...	4
DEPRESSED NOSE TIP	...		...	5
SHORT COLUMELLA		...	...	6

44	NOSE OPERATION			
STRAIGHTENING BONY BRIDGE		...		1
STRAIGHTENING SEPTUM			...	2
PARTIAL S.M.R.	...	...	...	3
TOTAL S.M.R.	...	...	...	4
INROLLING NOSTRIL MARGIN		...		5
ADVANCEMENT OF PROLABIUM		...		6
EXCISION OF ALAR BASES		...	...	7

45	DENTAL			
RETENTION PREMAXILLA	...		...	1
REMOVAL PREMAXILLA	...		...	2
ALVEOLAR COLLAPSE	...		...	3
DOG JAW	...	...	...	4
EXTRACTIONS	...	...	...	5
ORTHODONTICS	...	...	...	6
DENTURES	...	...	...	7
OBTURATOR HARD PALATE	...		...	8
OBTURATOR TOTAL	...		...	9
PROGNATHISM REAL	...		...	O
PROGNATHISM RELATIVE	...		...	X
OSTEOTOMY RAMI	...		...	Y
OSTEOTOMY & BONE GRAFT		...		XY

46	SPEECH THERAPY			
BEFORE OPERATION	...		...	1
AFTER OPERATION	...		...	2
IMPROVEMENT	...		...	3
NO IMPROVEMENT	...		...	4
NO SPEECH THERAPY	...		...	5

47	SPEECH (PRE-OP)

GROUP A — Normal Speech

NO FAULTS	... ...	1
MINOR FAULTS OF ARTICULATION		2
(Lateral S. Substitution and incorrect Tongue position)		
MAJOR FAULTS & DYSLALIAS	...	3

GROUP B — Articulation Correct But Nasal Escape of Air

MINIMAL NASAL ESCAPE	...	4
(Normal or excellent Speech)		
MEDIUM NASAL ESCAPE	...	5
GROSS NASAL ESCAPE	...	6

GROUP C — Articulation Incorrect And Nasal Escape of Air

MINOR FAULTS OF ARTICULATION		7
MAJOR FAULTS OF ARTICULATION		8

GROUP D — Unformed or Unintelligible Speech

UNFORMED SPEECH OF INFANTS		9
UNINTELLIGIBLE SPEECH IN CONVERSATION & READING		O
UNINTELLIGIBLE SPEECH EVEN OF WORDS IN ISOLATION		X

48	FEEDING			
SPOON	...	...	...	...	1
TUBE	...	...	...	...	2
BOTTLE	...	...	...	...	3
BREAST	...	...	...	...	4

49	SPEECH (POST-OP)

GROUP A — Normal Speech

NO FAULTS	... ...	1
MINOR FAULTS OF ARTICULATION		2
(Lateral S. Substitution and incorrect Tongue position)		
MAJOR FAULTS & DYSLALIAS	...	3

GROUP B — Articulation Correct But Nasal Escape of Air

MINIMAL NASAL ESCAPE	... ...	4
(Normal or excellent Speech)		
MEDIUM NASAL ESCAPE	... ...	5
GROSS NASAL ESCAPE	... ...	6

GROUP C — Articulation incorrect And Nasal Escape of Air

MINOR FAULTS OF ARTICULATION	7
MAJOR FAULTS OF ARTICULATION	8

GROUP D — Unformed or Unintelligible Speech

UNFORMED SPEECH OF INFANTS	9
UNINTELLIGIBLE SPEECH IN CONVERSATION & READING	O
UNINTELLIGIBLE SPEECH EVEN OF WORDS IN ISOLATION	X

50	LIP REPAIR	
HIRAULT-BLAIR		1
VEAU		2
SQUARE FLAP		3
Z-PLASTY—SKIN ONLY		4
PRIMARY FULL THICKNESS		5
SECONDARY		6
BREAKDOWN		7

LIP REPAIR

AGE AT OPERATION	51	52

53	SURGEONS	
		1
		2
		3
		4
		5
		6
		7
		8
		9
		0

Reverse side of pre-prepared transcript sheet.
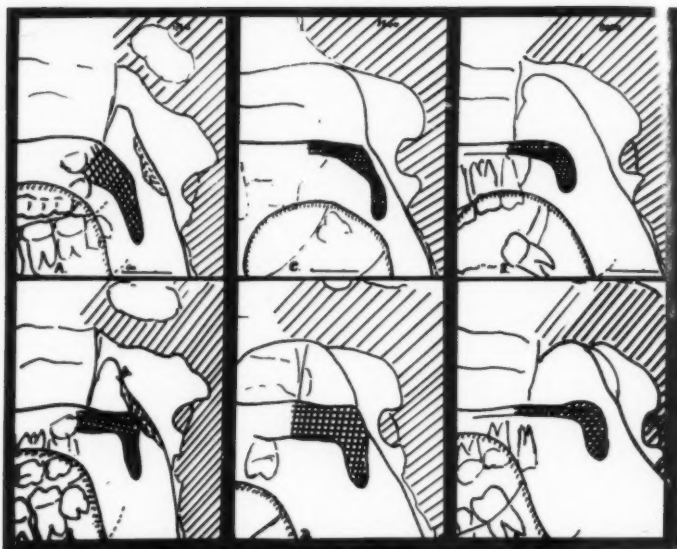
Fig. 8. Tracings of lateral X-rays all saying " Ee " (a) C.P. repair at eleven years —poor mobility six months after V-Y; (b) Speech therapy one year—normal speech; (c) C.P. repair at twenty-six years—before V-Y; (d) After V-Y— competent; (e) C.P. age twenty years—before V-Y; (f) After V-Y—nasal escape, needs Hynes pharyngoplasty.

VII. Results

Those who have heard cleft palate speech will judge what a handicap is present—one which may persist through life, and one which is greater than most, because *it cannot be concealed*.

It follows, therefore, that surgery of the palate for speech is not a light undertaking. It should not be considered by those who are untrained in this surgery, nor by those who meet the condition infrequently. Care should be taken that any repair should be the only operation on the palate, and the best.

Furthermore, since impressions of results are fleeting, all operations on the palate should be recorded in diagram, and the speech results carefully followed over a number of years.

In this series, all speech results have been cross-checked by other surgeons and speech therapists. The longest follow-up is fourteen years, the shortest two years, after treatment.

All cases have been reviewed in the past fifteen months, with the exception of twenty-six cases who have failed to respond. In these twenty-six cases the previous estimate of speech has been included, whether it has been good, bad, or indifferent.

The Power-Samas punch card system has been used to follow these cases. Information is taken from each case note and transferred to a pre-prepared transcript sheet by ringing each relevant item, provided that item has been noted in the history (Fig. 9).

Items from each transcript sheet are transferred to a punch card, in appropriate columns, using a machine for this purpose. Each punch card has the same series number as its transcript sheet.

The collected punch cards can now be fed into a main selector machine, and information can be extracted.

The tables which follow have been taken from the machine.

Comparison of speech results is not easy, because of the difficulty in laying down standards for assessment.

Veau divided his speech results into three classes :

i. Those with normal speech, to the untrained ear and to the phonetic expert.

ii. Those who can pronounce all phonetic sounds, but associate them with additional noises such as nasal escape or nasal tone.

iii. Those who cannot pronounce certain sounds, notably p, t, k, ch, s, j, z.

Others have classified results as :

i. Good speech (perfect or nearly so).

ii. Poor speech (with cleft palate stigmata).

iii. Bad speech (practically unintelligible).

In this series, speech has been graded as follows (Fig. 10).

49	SPEECH (POST-OP)	
GROUP A — Normal Speech		
NO FAULTS		I
MINOR FAULTS OF ARTICULATION		2
(Lateral S. Substitution and incorrect Tongue position)		
MAJOR FAULTS & DYSLALIAS		3
GROUP B — Articulation Correct		
But Nasal Escape of Air		
MINIMAL NASAL ESCAPE		4
(Normal or excellent Speech)		
MEDIUM NASAL ESCAPE..		5
GROSS NASAL ESCAPE		6
GROUP C — Articulation incorrect		
And Nasal Escape of Air		
MINOR FAULTS OF ARTICULATION		7
MAJOR FAULTS OF ARTICULATION		8
GROUP D — Unformed or		
Unintelligible Speech		
UNFORMED SPEECH OF INFANTS		9
UNINTELLIGIBLE SPEECH IN CONVERSATION AND READING		O
UNINTELLIGIBLE SPEECH EVEN OF WORDS IN ISOLATION		X

Fig. 10. Grades of speech.

Group A Normal speech—to the trained or untrained ear—no evidence of cleft palate stigmata.

Group B Correct articulation—but nasal escape of air to slight degree—producing good speech—weak on S and D. Some of these would pass for normal speech in public.   Fair.

Group C Incorrect articulation and nasal escape of air, with all stigmata of cleft palate speech.   Poor.

Group D Unformed or unintelligible speech.   Bad.

Results of this series are as follows :

CLEFT LIP GROUP I
PRE-ALVEOLAR CLEFTS
Sixty-two patients (including two with Group II cleft)   Males   42
(including four with Group III cleft)   Females 20

		Grp. I.i.R.	Grp. I.i.L.	Grp. I.ii.	Grp. I.iii	
Primary	..	14	27	—	3	=44
Secondary	..	5	11	—	2	=18
						62

CLEFT PALATE
119 POST-ALVEOLAR CLEFTS.   GROUP II

					Male	Female	
Primary ..	..	..	..	..	47	53	=100*
Secondary	..	..	..	..	7	12	= 19
							119

* Includes five submucous clefts, four congenital short palates.

CLEFT LIP AND PALATE
197 AVLEOLAR CLEFTS.   GROUP III

		Grp. III i.R.	Grp. III i.L.	Grp. III iii	
126—Primary lip and palate	..	19	54	28	=101
Primary lip Normal palate	..	6	18	1	= 25 =126
71 Secondary lip and palate	..	5	14	13	= 32
Secondary lip only	..	10	22	7	= 39= 71
		40	108	49	=197

Males   117 (60 per cent.)   Females   80 (40 per cent.)

364

CLEFT LIP AND PALATE
370 PATIENTS

	Group I Prealveolar clefts	Group II Post-alveolar clefts	Group III Alveolar clefts
Right	19		40
Left	38	119	108
Bilateral	5		49
	62	119	197
			= 378 clefts

CLEFT PALATE REPAIR
SPEECH RESULTS: GROUP II

Primary 100 clefts	Secondary 19 clefts		Primary and Secondary Total = 119
Post-op.	Pre-op.	Post-op.	
A 76 = 77·5%	A —	A 7	A 83 Perfect 70·4%
B 19 = 19·2%	B 2	B 11	B 30 Fair 25·6%
C 1 = 1%	C 15	C 1	C 2 Poor 1·7%
D 2 = 2%	D —	D —	D 2 Bad 1·7%
Live cases 98			Live cases 117
Deaths 2			Deaths 2

CLEFT PALATE REPAIR
SPEECH RESULTS: GROUP III

Primary 101 clefts	Secondary 32 clefts		Primary and Secondary Total 133
Post-op.	Pre-op.	Post-op.	
A 73 = 76·8%	A —	A 13	A 86 Perfect 67·7%
B 20 = 21·0%	B 11	B 19	B 39 Fair 30·7%
C — = —	C 20	C —	C — Poor —
D 2 = 2·1%	D —	D —	D 2 Bad 1·6%
95			Live cases 127
Deaths 6			Deaths 6

CLEFT PALATE REPAIR
SPEECH RESULTS GROUPS II AND III

	Primary Group II	Group III	Total			Secondary Group II	Group III	Total		
A ..	76	73	= 149	=	77·2%	7	13	= 20	=	39·2%
B ..	19	20	= 39	=	20·2%	11	19	= 30	=	58·8%
C ..	1	—	= 1	=	0·5%	1	—	= 1	=	1·9%
D ..	2	2	= 4	=	2·07%	—	—	—		—
	98	95	= 193			19	32	= 51		

Total palates = 244

365

MORTALITY

FOGH ANDERSON (1946) 1,000 cases
  Lip repair at two months
  Palate repair at two years

Lip repair	..	..	..	.. 726	Mortality	31=4·3%
Palate repair	..	..	..	.. 537	Mortality	3=0·6%

REIDY (1957) 370 cases

Lip repair	—Primary { at 3 months	2 }	Mortality 3 in 166=1·8%
	{ at 8 months	1 }	
	—Secondary at 26 years	1	Mortality 1 in 89=1·1%
Palate repair	—Primary at 1 year	5	Mortality 5 in 134=3·7%
	Total		Mortality 9 in 370=2·4%

PALATE REPAIR
SPEECH RESULTS—COMPARISONS

		Type of Operation	Total	A Normal	B Fair	C Poor	D Bad/Unin-telligible
1927	GREY TURNER	Langenbeck	90	11%	38·8%	27·7%	18·8%
1927	NITCH ..	Langenbeck	35	37·1%	—	48·6%	14·3%
1927	VEAU ..	Langenbeck	40	—	25%	15%	60%
	VEAU ..	Veau Technique	100	40%	—	60%	—
1933	VEAU ..	Veau V-Y	100	62%	—	23%	15%
1933	WARDILL	Langenbeck Gillies Fry Veau V-Y + Pharyngoplasty	38	84%	—	—	16%
	RITCHIE ..	—	—	42%	43%	—	—
	VAUGHAN ..	—	—	43%	26%	—	—
	BENTLEY and WATKINS	V-Y	—	51%	27%	—	—
1951	HOLDSWORTH	V-Y	85	47%	43%	—	—
1949	OLDFIELD ..	V-Y Primary	113	61%	32·8%	—	6·2%
		Secondary	70	25·7%	60%	—	14·8%
1957	REIDY ..	V-Y Primary	193	77·2%	20·2%	0·5%	2%
		Secondary	51	39·2%	58·8%	1·9%	—

VIII. Certain points of controversy arise

Simple lip clefts are defects of soft tissue.

There is no difficulty in suckling. The problem is entirely one of cosmesis. The great difficulty is to persuade the parents to wait.

Common practice in this country is to repair the lip at six to nine months, under general anaesthesia, i.e. after weaning, and when the child is old enough and lusty enough.

Current practice in U.S.A. is that of repair in the first month of life. Only one case in this series was treated at one month.

Attempts have been made in this country to follow the U.S. pattern.

It looks spectacular, and it is no doubt good treatment of the parents.

366

Langenbeck or V-Y (Fig. 11).

Whole object of surgery of cleft palate is to provide adequate mechanism with a long enough soft palate to allow patient to close nose from mouth in speech and swallowing.

Most plastic surgeons in this country use the V-Y procedure.
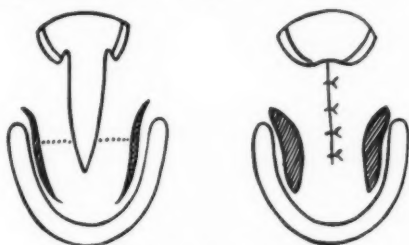
Langenbeck 1862.
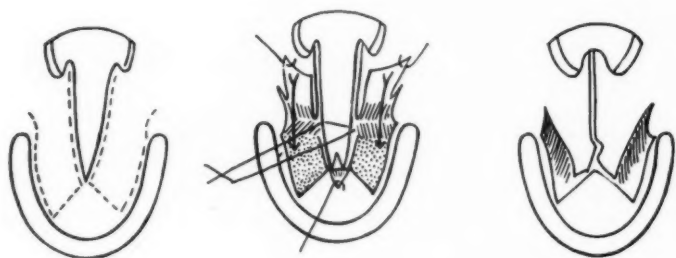
V-Y Retroposition. of palate.

Fig. 11. Comparison of Langenbeck operation and V-Y procedure.

The modern Langenbeck procedure calls for suture in two layers, and the dissection is much the same as in the V-Y, but from the diagrams it must appear obvious that detachment of palatal flaps anteriorly will allow more movement of flaps in posterior direction in the V-Y procedure.

Excision of " pre-vomerine bone "

This applies to Group III iii only.

D. Browne recommends excision of cartilage behind premaxilla at three months. This allows manual replacement and fixation of premaxilla between the lateral alveolar elements to prevent collapse.

It is claimed that this procedure allows repair of both lip clefts more easily at four months, and gives better contour to lip and nose tip at

later date. On the other hand, retention of projecting premaxilla as been practised in this series, and lip repair is undertaken one side a a time at third month and fourth month. The lip moulds the premaxilla back; nevertheless, the premaxilla does not always lie perfectly in the alveolar arch except in moderate cases. However, the projection of the premaxilla does stimulate growth of the repaired lip and prolabium in front of the premaxilla. The net result is that few of these Group III iii lips are retroposed and tight, and none of the primary cases in this series (of 126) has required an Abbé flap, the object of which is to add fullness to the upper lip.

The pre-lip operation procedure of Kerr McNeill, whereby he replaces the premaxilla before surgery, promises to solve much of this problem.

Pharyngoplasty in infants

It was not uncommon in the early 1930s for primary repair of palate to be accompanied by Wardill's pharyngoplasty.

In this series, pharyngoplasty has not been performed in any primary cases in an infant, but it has been required as a secondary procedure in certain cases of this series in which a primary V-Y retroposition had already been performed in infancy.

The results of the V-Y retroposition alone in this series show that the operation can and does give good permanent results.

Hynes (1954) argues that 30 to 40 per cent. of cases after V-Y repair of palate still have short palates. He has advised pharyngoplasty at eighteen months plus the simplest repair of palate without detachment of palatal muscles from posterior border of hard palate. No figures are given of his speech results following V-Y repair, which must be compared eventually with the results of his latest procedure.

Use of Abbé flap

It has already been noted that three only of Group III iii cases in this series have required an Abbé flap, in order to relieve tightness across the upper lip, and none of these cases has been primary in this series. This is attributed to the retention of the premaxilla in its projected position, so that repair of the lip in front slowly moulds the premaxilla back, but at the same time the premaxilla stretches and stimulates growth of the lip elements and prolabium.

There would appear, therefore, to be no indication, as has been suggested, that the Abbé flap is a useful procedure to be performed at three months of age, when so few are required in later life.

There is still less requirement for an Abbé flap in a unilateral cleft (Group III.i.)

CONCLUSIONS

Few cases in plastic surgery stay with the surgeon for so many years of treatment and observation as do those of palate repair, and few cases

bring such a satisfying reward as that of hearing a cleft palate child speak normally.

The greatest difficulties present in the Group III clefts, unilateral and bilateral. The plastic surgeon maintains that palate repair and restoration of normal speech mechanism is of the greatest importance. The orthodontist bemoans the alveolar collapse that follows early palate repair. The relatives are concerned with the appearance of their baby from the date of birth, often for their own social peace of mind. The patient is, therefore, in danger of becoming a misguided missile—moving irregularly between plastic surgeon and dental surgeon during the early years of life which are so important.

I believe that a happy cooperation can be achieved solely for the benefit to the patient by the orthodontist and plastic surgeon changing places in the timing of treatment. Early correction of the arch deformity can be rapidly achieved, setting back the premaxilla (after the manner of Kerr McNeill) into a good arch in the unilateral cases. This can be followed by the repair of lip, and palate at the usual intervals, while the orthodontist maintains his benevolent interest : in fact, there would be less urgency for lip repair.

In the bilateral cases, where the orthodontist has replaced the premaxilla into correct alignment, the repair of both lip clefts at one operation is facilitated. The price that *may* be paid is the subsequent poor development of the prolabium and the risk of tightness of the upper lip, but this has yet to be seen in this procedure.

At the commencement, the objectives of treatment were stated to be that the patient—should look well, should feed well, should speak well.

The majority speak well.

All eat well.

But many in Group III (bilateral) cases do not look well, either externally or orthodontically, and it is in this group that future improvement must be achieved.

OTHER STATISTICS

Patients 370 { Males 211 / Females 159 }

OTHER CONGENITAL DEFECTS

Congenital heart	..	..	..	5	Nasolabial cleft	1
Mongolism	..	..	..	1	Mental deficiency	9
Micrognathia	..	..	..	4	Orthopaedic deformity	1
Treacher Collins	..	..	..	2	Deafness	2
Syndactyly	..	..	..	1		

AGES OF PALATE REPAIR

At	1 year	..	..	..	134	At 9 year	8
	2 ,,	..	..	..	13	10+ ,, ...	22
	3 ,,	..	..	..	7	20+ ,, ...	14
	4 ,,	..	..	..	3	30+ ,, ...	9
	5 ,,	..	..	..	7	40+ ,, ...	7
	6 ,,	..	..	..	2		
	7 ,,	..	..	..	7		238
	8 ,,	◄.	..	..	5		—

PHARYNGOPLASTY

Wardill	..	..	..	..	9	Hynes	..	..	8
Rosenthal		..	..	..	3				
For short palate in 8						For capacious pharynx in 7			

DENTAL (188 cases)

Removal premaxilla	..	..	11	Total palate obturator	..	..	1
Alveolar collapse ..	..	..	13	Real prognathism	..	..	3
Dog jaw ..	..	..	4	Relative prognathism	..	..	3
Obturator hard palate	..	..	9				

OTHER PROCEDURES (188 cases)

Cupid's bow	..	..	27	Z-plasty vestibular folds ..	..	4
Upper epithelial inlay	..	..	7	Narrowing nostril floor ..	..	28
Abbé flap ..	..	..	3			

STATE OF PREMAXILLA (188 cases)

Marked protrusion	..	..	38	Good position	..	33
Moderate protrusion	..	..	15			

PALATE REPAIR—Groups II and III (304 cases)

Anterior Veau flaps (R. and L.)	5	4-flap repair	..	..	57
Veau flap and mucosal flaps	..	10	Gillies Fry ..	..	6
Mucosal flaps alone	..	55	Tubed flap ..	..	1
Removal horizontal vomerine spur	6	Repair of hard palate fistula	..	17
V-Y retroposition	..	..	168		

SPEECH THERAPY—Groups II and III (304 cases)

Before operation ..	..	..	15	No speech therapy	..	70
After operation	..	..	65		

FEEDING—Groups II and III (304 cases)

Spoon fed ..	..	..	..	43	Bottle fed ..	90
Tube fed ..	..	..	..	2	Breast fed ..	17

ACKNOWLEDGMENTS

REFERENCES

BROWNE, Denis (1949) *Ann. Roy. Coll. Surg. Engl.* **5**, 169.
CALNAN, J. S. (1953) *Brit. J. plast. Surg.* **5**, 286.
——————————(1954) *Plast. reconstr. Surg.* **13**, 275.
——————————(1954) *Brit. J. plast. Surg.* **6**, 264.
——————————(1956) *Brit. J. plast. Surg.* **8**, 265.
——————————(1956) *Brit. J. plast. Surg.* **8**, 4.
——————————(1957) *Brit. J. plast. Surg.* **10**, 2.
DAVIS, J. S. and RITCHIE, H. B. (1922) *J. Amer. med. Ass.* **2**, 1323.
DORRANCE, GEORGE M. (1925) *Ann. Surg.* **82**, 208.
——————————————(1933) *The Operative Story of Cleft Palate.* Philadelphia.
  Saunders.
———————————— and BRANSFIELD, J. W. (1943) *Ann. Surg.* **117**, 1.
———————————— (1946 *a*) *Plast. reconstr. Surg.* **1**, 145.
———————————— (1946 *b*) *Surg. Gynec. Obstet.* **84**, 878.
FOGH-ANDERSON (1939) *Plast. chir.* **1**, 35.
——————————(1942) *Inheritance of Harelip and Cleft Palate.* Arnold Busck.
——————————(1946) *Acta chir. Scand.* **94**, 213.
——————————(1948) *Plast. reconstr. Surg.* **3**, 186.
——————————(1953) *Acta. chir. Scand.* **105**, 92.
GILLIES, H. D. and FRY, W. K. (1921) *Brit. med. J.* **1**, 335.
HYNES, W. (1950) *Brit. J. plast. Surg.* **3**, 128.
——————(1953) *Ann. Roy. Coll. Surg. Engl.* **13**, 17.
——————(1954) *Brit. J. Plast. Surg.* **7**, 242.
——————(1957) *Brit. J. plast. Surg.* **10**, 2.
KILNER, T. P. (1937) *St. Thom. Hosp. Rep.* **11**.
——————————(1937) *Brit. J. Surg.* **9**, 33.
LE MESURIER, A. B. (1949) *Plast. reconstr. Surg.* **4**, 1.
——————————(1955) *Plast. reconstr. Surg.* **16**, 422.
McNEILL, C. K. (1954) *Oral and Facial Deformity.* London. Pitman.
——————————(1956) *Brit. dent. J.* **101**, 191.
STARK, R. B. (1953) *Plast. reconstr. Surg.* **12**, 41.
——————————(1954) *Plast. reconstr. Surg.* **13**, 20.
STREETER, G. L. (1948) *Contrib. Embryol.* **32**, 133.
VEAU, V. (1931) *Division Palatine.* Masson. Paris.
——————(1922) *Ann. Surg.* **76**, 143.
——————(1932) *J. Chir.* **40**, 321.
——————(1936) *J. Chir.* **48**, 465.
—————— and BOREL-MAISONNY, S. (1936) *Proc. Soc. int. de Logopédie et Phoniatrie.*
—————— and RECAMIER, J. (1938) *Bec. de Lievre.* Masson. Paris.

DONATIONS

THE CHEST WALL

Lecture delivered at The Royal College of Surgeons of England

on

25th April 1958

by

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DEFINITION

THIS TALK CONCERNS the chest wall, and the emphasis will be on the clinical aspects of the subject.   And, because the principal problem that confronts the clinician is to distinguish between new growths and other swellings, the word " tumour " will be taken to mean abnormal lumps due to various causes.   The lesions concerned are so numerous, albeit the majority are neglected in standard works upon surgery, that it will not be possible to do more than to touch upon some of the principles involved in the pathology, the diagnosis and the treatment.

The chest wall includes everything that confines and protects the thoracic viscera. It is partly responsible for respiration and its movements are vital to human life.

General principles

The bones of the thoracic cage comprise but a part of this intricate mechanism. Other structures such as the intercostal muscles, the fasciae, the lymphatic glands, the blood vessels and nerves, the extra-pleural connective tissues (such as Sibson's fascia) and the parietal pleura, exist. All are subject to pathological changes.

The ribs, connected anteriorly to the sternum, through the costal cartilages, and at the back to the vertebrae, form a series of hoops. *Anomales that distort one part of this system alter the shape of another,* and the practical application is that any prominence or depression must be considered in relation to the thoracic cage as a whole.

One cannot assume that a tumour will be easy to see or feel; even in a thin subject an important area is covered by meaty superficial muscles (such as the latissimus dorsi), the breasts, and the scapulae. Moreover a pathological process that starts deep grows with the least resistance by displacing the pleura and the lung inwards.   Even when a tumour is palpable it is probable that, like an iceberg, most of its bulk is " below the surface."

The chest wall is frequently invaded by pathological growths originating inside the thorax. Hodgkin's disease, carcinoma of the bronchus, dermoid and desmoid tumours of the mediastinum, actinomycosis, aortic aneurysm, etc., can extend through the parietes and produce pathological lumps

372

that the unwary regard as primary tumours. Endothelioma of the pleura nearly always causes perplexity in this way. This new growth, that probably originates somewhere in the bronchial tree, spreads as a dense carapace over the lung, the mediastinum and through the diaphragm. The superficial parts of the tumour invade the chest wall, destroy and separate the ribs, and produce hard, palpable, lumps. These patients die from exhaustion and because they cannot breathe.

Fig. 1. Part of the skeleton of the thorax of a small boy who died from rickets. The specimen shows a typical rickety rosary and deformity of the costal cartilages.

Unlike the abdominal wall *the thoracic cage is often implicated in general diseases,* because it contains bone and lymphatic glands. Paget's disease,

Fig. 2. This specimen, from an infant aged eighteen months shows the thoracic deformities which can be produced by rickets.

secondary new growths, myelomatosis, rickets, scurvy, fragilitas ossia, to mention but a few, can deform or distort the bones (Figs. 1 and 2); whilst tuberculosis, sarcoidosis, the leukaemias and lymphomata cause lymphatic enlargements.

Many lumps that occur are clinically silent for a long time and some are revealed by radiology. Unfortunately it is seldom wise to rely on X-ray films for a diagnosis because so many shadows overlie each other. Not

374

only can one not distinguish accurately between the various rib diseases but one cannot always know whether a shadow has been cast by a mass in the chest wall, the pleura, or the lung. The point can sometimes be settled by inducing an artificial pheumothorax, and after thoracoscopy by taking a biopsy from within ; but this may fail just when help is most needed.

Because of the diagnostic difficulties in these cases there is a tendency to procrastinate in the hope that time will dispel the trouble. It is my purpose to emphasise that *practically all lumps that appear in the chest wall are serious; that delay is dangerous; that the appropriate serological tests and biopsy are obligatory; and that many of the diseases concerned can be cured if properly tackled.*

Experience with local excisions has shown that if it is appropriate that a lump be removed surgically, *the operation must be thorough.* When a conflict arises between the operation that a surgeon considers necessary, in an individual case, and that which the subsequent respiratory requirements will allow, the following general principles dictate the action to be taken.

Large tumours can be excised ; that is, neither the size of the tumour nor the fact that several ribs must be taken away are the limiting factors. Adequate post-operative respiration depends not only on the movements of the thoracic cage but, more important, upon the fact that all components and parts of that structure must function in harmony. When sections of several ribs have been taken out an unsupported area is created : this moves paradoxically on respiration. Paradoxical respiration impedes pulmonary ventilation and the larger the defect the worse the anoxia. Two ways are available to offset this limiting factor. The unsupported area can be passively immobilised by internal or external splintage (bone grafts or prostheses) ; or the underlying lung can be taken away with the chest wall tumour. The rationale of the latter is that a person can breath effectively with one lung ; the same person cannot live with two lungs as long as one empties when the other fills.

Anomales produced by alterations in the shape of the thorax

Harrison's sulcus, the rickety rosary, and deformities produced by diseases such as osteomalacia are familiar. But the causes of local deformities produced by congenital, traumatic or general causes are not so obvious.

It is common for patients to come to hospital with a diagnosis of chondroma of the costal cartilage. In fact *tumours of the costal cartilage are pathological curiosities.* Most of these cases are examples of assymetrical rib growth. If one dissects the thoracic cage of a foetus or an infant one is struck by the unevenness of the growing ribs and cartilages, and surprised that the disordered anatomy becomes rectified in later life. If the two halves of the chest are to become mirror images each pair of ribs must grow in a comparable direction and at the same speed

as its opposite number. If one grows differently from its fellow the costal cartilage generally absorbs the inequality by buckling slightly and becoming prominent (Fig. 3). This produces no symptoms ; but may be noticed
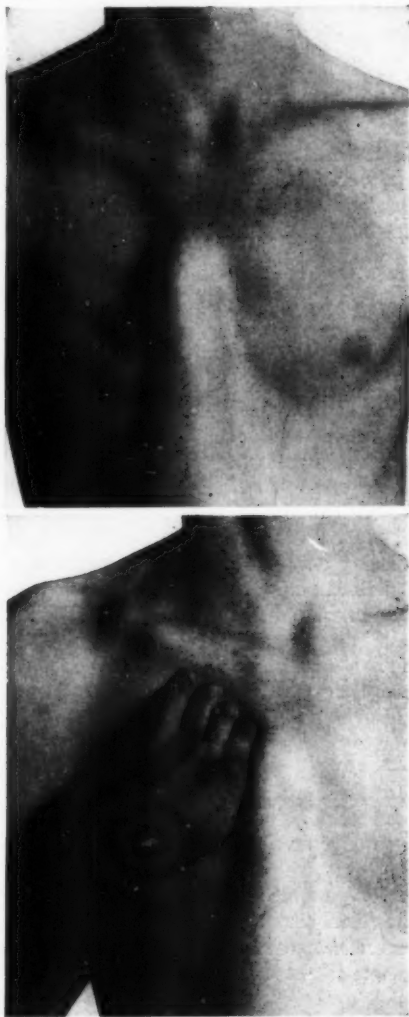
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Fig. 3. Clinical photographs of a boy who had a prominent " lump " in his costal cartilages. He had several other congenital deformities and it was curious that his deformed right hand exactly fitted the depression in the chest wall.

376

when the patient bathes, looks in a mirror, or loses weight for some reason. A tumour is immediately suspected and repeated palpation produces local tenderness and a diagnosis of " chondroma " is made. In some cases local areas of rib or the free costal margin are severely deformed at birth and such anomales remain throughout life.

In 1921 Tietze described a painful enlargement of one or more costal cartilages. Since then attempts have been made to develop this condition into a specific disease. The aetiology has always been vague (secondary infection, vitamin deficiency, allergic chondritis) and the numerous specimens that have become available, as a result of operations, have only shown doubtful histological oedema. Tietze's disease is not a specific entity ; it is certainly not tumourous ; it needs no surgical operation, and the symptoms resolve spontaneously.

The *sternum can be deformed.* The bone may be angled forwards, producing a local prominence where the manubrium and the gladiolus join ; or the lower half may be angled backwards so that the xiphoid impinges on the vertebral column. The latter is called *pectus recurvatum;* it is caused by a congenital absence of muscle in front of the central tendon of the diaphragm and it results not only in cardiac displacement, but in irregularities in the costal cartilages. Both these sternal deformities may need surgical correction in childhood for cosmetic reasons, and to avoid cardio-respiratory complications later in life.

There are various reasons, other than new growths, why local prominences may occur in ribs. The hard boss of a *cervical rib* is well recognised ; but *fused ribs, bifid ribs* or *callus* around a fracture may be confusing. A special warning is necessary about callus. If a patient has had an injury and is known to have sustained a fracture, the palpable callus that heals the bones is easy to explain. But not all rib fractures are " pathological " or caused by external injuries. " Cough " fractures occur in the lower part of the chest and are considered to be due to the efforts a patient makes to suppress a persistent, annoying cough. The pain that follows is apt to be wrongly diagnosed as pleurisy and when, later on, a palpable lump appears the idea of a tumour is created. The X-rays in these cases may not help because the callus obscures the original fracture. Another rib fracture occurs spontaneously in the upper part of the chest. Idiopathic fractures of the first two ribs are not uncommon as a radiological entity. There is no trauma and no pain in these cases and the fractures are generally comminuted ; they heal readily and produce callus that may be palpable in the supraclavicular fossa. No treatment is needed and no anxiety need be felt.

The Sterno-clavicular joint

A variety of swellings occur in this area. The inner end of one clavicle may be slightly larger than its fellow, or the joint the seat of *osteoarthritis* in which case the lipping can cause a palpable ridge. These joints are painful and the X-rays often do not clarify the diagnosis.

377

Tuberculous arthritis is also quite common. It may be part of a general tuberculous infection, or a solitary manifestation. The joint becomes obscured by a red, painful, doughy swelling; it aches when the arm is moved upwards and it gathers slowly over a period of weeks or months. Radiographs eventually show disintegration of the adjacent bones and if treatment is withheld one or more sinuses discharge upon the skin. In the early stages the process may be controlled by the appropriate antibiotics but later on excision of the diseased bones becomes necessary.

The inner end of the clavicle, or the whole bone, is sometimes involved in *Paget's disease*, *syphilis* or *tumours*.

We may note in passing that the first costal cartilage calcifies before any of the others. When this happens in a young adult the opacity which is obvious on radiographs can cause mistaken diagnosis.

Inflammations of the chest wall

Acute pyogenic abscess need not detain us; but there is a condition that mimics acute inflammation and whose treatment, if incorrect, is disastrous.
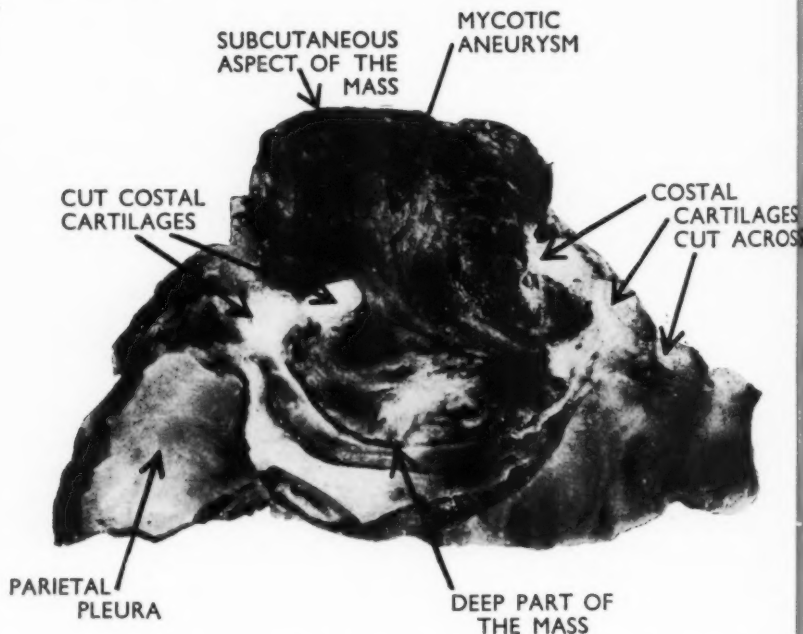
Fig. 4. Part of the chest wall of a boy aged nine who died as a result of rupture of a mycotic aneurysm which originated in the internal mammary artery.

For some unexplained reason *mycotic aneurysm* of the internal mammary artery is a definite entity in children and young adults. The " tumour " that results grows slowly and displaces or destroys several costal cartilages (Fig. 4) : since it generally contains clot it feels rather solid, and in places is fluctuant. It is hot and tender like a large abscess. As a casualty dresser I saw such a case treated by confident incision and the result is imprinted in my memory.

Tuberculous cold abscess of the chest wall is familiar to you all ; but few surgeons treat the condition well, because there are fallacies concerning the pathology.

Fig. 5. This patient has a cold abscess pointing at the lateral edge of the erector spinae muscle. It originated in a paravertebral extra-pleural gland.

379

32—2

Clinical experience and museum specimens show that upon rare occasion tuberculous osteitis and periostitis of rib occur. A destructive lesion of a costal cartilage is also a possibility. But none of these is the usual cause of the ordinary cold abscess one sees in out-patients (Fig. 5). The patient is nearly always a fit, young, adult who has noticed a symptomless swelling : he may also have pulmonary tuberculosis but he does not have Pott's disease of the spine. What, then, is the cause of the cold abscess ?

It is now believed that the infection starts, in practically every case, in a tuberculous lymph gland and that it runs a course comparable to cervical adenitis. The organisms are frequently bovine and the lesion is a collar stud abscess in which the deep, culprit gland may be a long way away from the lump on the chest wall. The vulnerable glands are situated extrapleurally near to the vertebral column, along the intercostal spaces and along the internal mammary vessels. The anatomists do not emphasise these lymph glands but they are familiar to surgeons who have done thoracoplasties for pulmonary tuberculosis, and in these cases they contain demonstrable organisms. Caseation occurs and the pus tracks round the chest wall in the same plane as the intercostal nerves. It comes to the surface either with the posterior primary divisions at the outer border of the erector spinae ; with the lateral divisions in the anterior axillary line, or with the terminal branches near to the costal cartilages.

· Fig. 6. This ulcer, which had a rolled, hard edge, was considered by many who saw it to be malignant. The biopsy revealed typical tuberculosis, the cause of which was a caseating gland in the anterior mediastinum.

Fig. 7.　This photograph is of the side of the chest of a middle-aged woman who came to the hospital with a diagnosis of carcinoma of the axillary tail of the breast. Slowly, over a period of weeks, the tumour broke down, and a biopsy showed it to be tuberculous. It arose from an underlying, localised, and apparently quiescent, tuberculous empyema.

The clinical importance of these observations is that before attempting to excise a cold abscess of the chest wall one must verify the origin of the infection.　To do this a small volume of some radio-opaque liquid (e.g., lipiodol) can be injected into the abscess, massaged a little, and films may then show the ramifications of the track.　Merely to cut away the top of a collar stud abscess, and perhaps a fragment of normal rib for good measure, is poor surgery.

381

It sometimes happens that tuberculosis, originating in an anter or mediastinal lymph or in a long-standing, localised, chronic empye na comes to the surface differently. A firm " tumour " presents ; it is so d, hard and painless ; and there is nothing at first to suggest the real cau se. It feels like a growth (Figs. 6 and 7). After a time the lesion becomes fluctuant and, if left, a sinus develops ; but even then the indurated margins are not obviously tuberculous. To underline the difficulty in diagnosing such cases correctly I must say that recently such a patient, admitted to one of my beds, was considered to be suffering from a primary or secondary neoplasm by several surgical colleagues. Correct diagnosis rests upon a biopsy. The story will not surprise any surgeon who reflects upon cases in which tuberculosis mimics carcinoma in the tongue or the rectum.

Gumma, due to syphilis, behaves in much the same way (Fig. 8). Gummata occur in the mediastinum : some become large and imitate tumours like dermoids or teratomata, others penetrate through an intercostal space (nearly always the second or the third) near to the edge of the sternum and present in a way indistinguishable from the " tuberculous tumours " described above. They respond well to antisyphilitic treatment and poorly to excision.

I have twice seen *syphilitic osteitis* affecting a rib and in neither patient were there other specific changes. Both patients were wrongly considered to have extensive secondary deposits in the ribs. The affected bones were large, involved practically throughout their lengths, and tender to palpate. The X-rays showed total disorganisation of the normal pattern and excisions were done because the diagnosis was doubtful. The histology, the Wassermann reactions, and the ultimate response to correct treatment were conclusive ; and the lesson here is that when the diagnosis is in doubt, tests to eliminate syphilis are needed.

Another specific infection that involves the ribs is *typhoid fever*. This gives rise to a slowly developing, sclerosing lesion that is difficult to diagnose unless the possibility is remembered and unless organisms can be isolated. The infection occurs out of the blue at any time up to thirty years after the original fever. It is very rare.

Osteomyelitis of rib, due to streptococci or staphylococci, is uncommon ; it exists in one of three forms. The infection may reach the rib from the lung or when an empyema has been drained by local rib resection. It may occur " de novo," and then causes a pyrexial illness during which pus accumulates beneath the periosteum of the first or the second ribs. The pus produces a bag that displaces the pleura and the lung downwards, and this accounts for the radiological opacity, that resembles an extrapleural pneumothorax which, post-operatively, has filled with blood. The X-ray opacity is typical and aspiration of pus clinches the diagnosis. But the uninitiated is apt to think that the radiological opacity is a massive new growth inside the thorax. Two points need emphasis. Sequestration of the rib seldom occurs in less than four to six weeks, and many of these
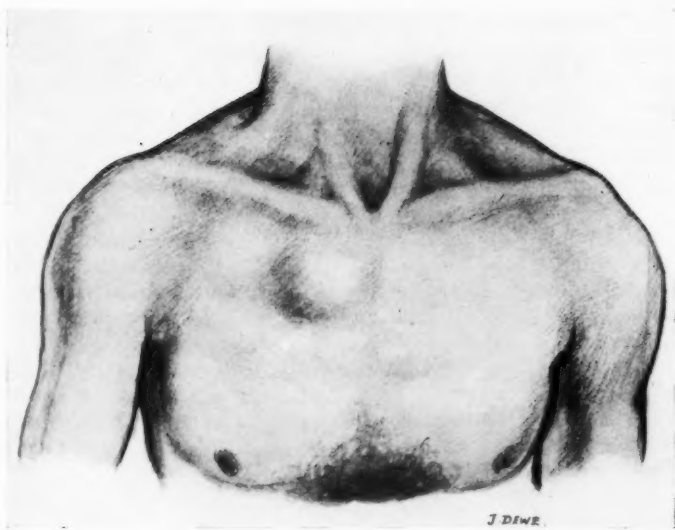
Fig. 8. These two drawings show a typical parasternal gumma. At first the "tumour" was hard and some considered it to be a "chondroma of costal cartilage"—for practical purposes the latter diagnosis is always wrong.

383

cases resolve well with aspirations and the exhibition of the appropriate antibiotics. The third type of osteomyelitis often follows trauma, such as a blow on the chest whilst boxing, and the patient complains of a painful, hard swelling in a rib. X-rays show sclerosis of the bone and the diagnosis remains in doubt until the offending piece has been removed. On section the rib contains a small amount of pus from which staphylococci grow.

Fibrous dysplasia of rib

This condition is so important as to merit a section to itself. Monographs about bone diseases describe fibrous dysplasia (fibrocystic disease of bone) as a generalised disorder affecting the skeleton as a whole and characterised by changes in the bones similar to those caused by parathyroid tumours, but without alterations in the calcium metabolism, and with normal parathyroids. Some of these patients have, in addition, various endocrine disturbances that cause precocious puberty and pigmentation in the skin. Of all the bones that are affected the ribs are said to be relatively immune.
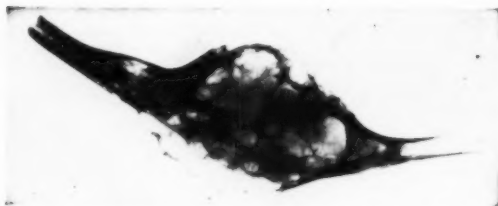
Fig. 9a. Radiograph of the specimen removed. It is typical of fibrous dysplasia and shows the soap bubble arrangement of the bony trabeculae.
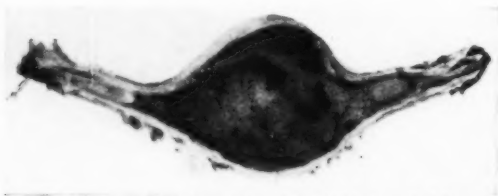
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Fig. 9b. Painting of the cut surface of the lump. Histologically it was a typical fibrous dysplasia. The operation was done four and a half years ago and no recurrence has appeared.

But during the last twenty years thoracic surgeons have described many examples of fibrous dysplasia of rib. At first these lesions were cut out because they were thought to be primary tumours of rib, and it was the histological sections that revealed the nature of the tissue.

Fibrous dysplasia of rib differs from the disease described above in the following ways. The lumps that appear in the ribs are usually solitary. Upon rare occasion multiple rib " tumours " are present ; but it is unusual for other parts of the skeleton to be abnormal. There are no biochemical changes and nothing to suggest a general disease. The reason why the term " fibrous dysplasia " is used is that histologically the two conditions are similar : but the surgeon may prefer to look upon " fibrous dysplasia " of rib as " fibroma " of rib, that is a benign growth of fibrous tissue (Fig. 9). The idea that, in some way, it is an uncontrolled, and hence an unnatural, response to healing has gained ground since all the intermediate stages between a typical fracture and fibrous dysplasia occur histologically.

The abnormality in the rib, being silent, is generally discovered radiologically. The " tumour " builds up insidiously and after months, or years, the normal outlines of the rib are expanded and the structure completely replaced. A mass the size of a grapefruit may ultimately grow. This condition does not produce metastases and does not recur after excision.

When the specimen is cut open the surface is firm, white to pale maroon in colour, and it contains gritty particles that grate on the knife. The " tumour " is encapsulated or at least sharply demarcated from surrounding structures. In a well grown case the histology is typical. The mass is formed by proliferating fibroblasts. It contains numerous small blood vessels, spicules of adult normal bone and areas of necrosis and blood pigment or old haemorrhage.

The clinician is influenced by the following thoughts. The anomale arises without cause, silently at first, and is generally discovered radiologically ; the lump appears and grows slowly, often intermittently, and sometimes remains unchanged for years ; its nature cannot be diagnosed for certain until the specimen itself can be examined ; radiologically it resembles multiple myelomatosis or benign giant cell tumour of bone (both of which are very rare in ribs) ; but it is usually mistakenly diagnosed radiologically either as a cartilagenous tumour or as an haemangioma of rib (neither of which casts a comparable shadow). It never becomes malignant ; its progress is not influenced by radiotherapy, and when removed surgically it does not recur.

Eosinophilic granuloma occurs in the thorax but, apart from the diagnostic problems it sets, it is seldom of clinical importance. Radiologists often see small, circumscribed, punched out areas in the ribs. These are single, they cause no symptoms, and should not be confused with secondary new growths because the area of rarefaction is clear cut. The proof as to what these shadows are rests upon the histological appearances of specimens that have been removed for diagnosis. The opposite radiological picture, namely a circumscribed area of increased density also occurs though more rarely, and it has been assumed that these are healed, and perhaps calcified, eosinophilic granulomata.

New growths of the chest wall

I shall summarise briefly some of the knowledge that now enlighte s this subject, and make practical distinctions between the diseases alrea y described and those that follow.

Secondary malignant growths are the principal tumours that occur n the chest wall. These originate particularly in the breast, the genitali , the kidneys and suprarenals, the thyroid, etc., and they involve the ri s and the vertebrae. Pain and pathological fractures are common an radiographs show the typical changes in the architecture of the bone . The diagnosis is seldom in doubt, and local treatment of is no avail.

Sometimes metastases, and notably those derived from the kidneys an the suprarenals, behave differently and actually produce a large palpable mass in the parietes. The tumour usually grows quickly ; the soft tissues are invaded and the axillary nodes may be involved. The skin over the lesion becomes hot, dusky in colour, and the veins are prominent. An auscultatory murmur is often heard and true pulsation may be present.

Do not mistake a secondary malignant growth of this type for a primary sarcoma of the chest wall because the latter can sometimes be cured by surgical excision. Remember that, in both, the ribs can be destroyed and the radiological appearances are not pathognomonic.

The only tumours of the chest wall that pulsate are aneurysms and secondary growths; but distinguish carefully between true and transmitted pulsations. The latter are seldom due to primary lesions in the chest wall. Auscultatory murmurs are less easy to be dogmatic about ; they may originate inside the thorax, or be caused by collateral vessels, or haemangiomata, etc., in the parietes.

The next common group of chest wall tumours are those that grow from the intercostal nerves or from the sympathetic chain. *Neurofibromata* and *ganglioneuromata* are both confined to the paravertebral parts of the thorax and they impinge upon the vertebral column in preference to spreading laterally. The former are generally confined to one intercostal space, the latter may involve several sympathetic ganglia and extend vertically.

Neurofibromata grow extrapleurally and originate in the sheaths of the intercostal nerves ; they spread through the intercostal space but do not invade either the muscles or the adjacent bones. The majority are solitary and benign and as they enlarge they push the ribs on either side out of alignment ; but they never invade the bone like a cancer. The ganglio-neuromata are particularly liable to grow into, and so to expand, one or more intervertebral foramina—a point that can often be demonstrated in lateral tomographs—and the bodies of the vertebrae with which they come into contact may be rarefied and rotated, producing scoliosis.

Pain is unusual and most of these growths are picked up in antero-posterior X-ray films. The fact that the intercostal nerves are not demons-trably paralysed is a point of diagnostic significance. However large

these tumours become they never transgress the parietal pleura until malignant changes have supervened or unless they were malignant from the start. But the adjacent lung is sometimes adherent to the tumour by intrapleural adhesions.

The radiological appearances are of a homogeneous opacity that is slightly lobulated and sharply circumscribed, and the diagnosis is seldom in doubt. But there are other benign tumours that originate in the inter-costal tissues—such as *myxoma, lipoma, lymphangioma* and *fibroma*—from which these must be separated (Figs. 10 and 11). If a neurofibroma lies in front of the necks of the upper thoracic vertebrae it may look (in antero-posterior films) like a small mediastinal goitre. This is a bad mistake because you cannot excise a neurofibroma, growing in the paravertebral gutter, through a collar incision in the neck. The two can be differentiated because the neurofibroma lies much further back in the chest, and never displaces the trachea or the oesophagus.
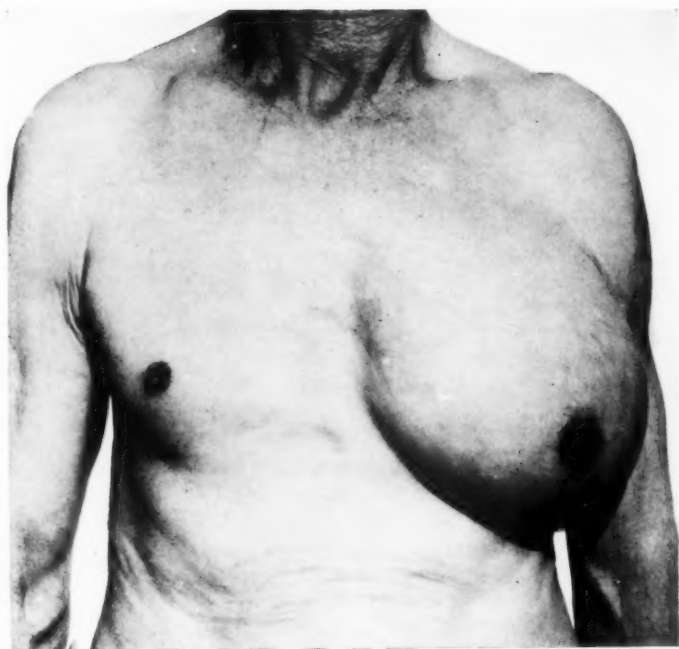
Fig. 10. Photograph of a middle-aged man suffering from a subpectoral lipoma originating in the chest wall. Lipomata can be intra-thoracic, extra-thoracic or a combination of the two.

387

Although practically all these tumours are benign they should always be excised to prevent distortion of the bones, pressure on nerves and extra-thecal extension.
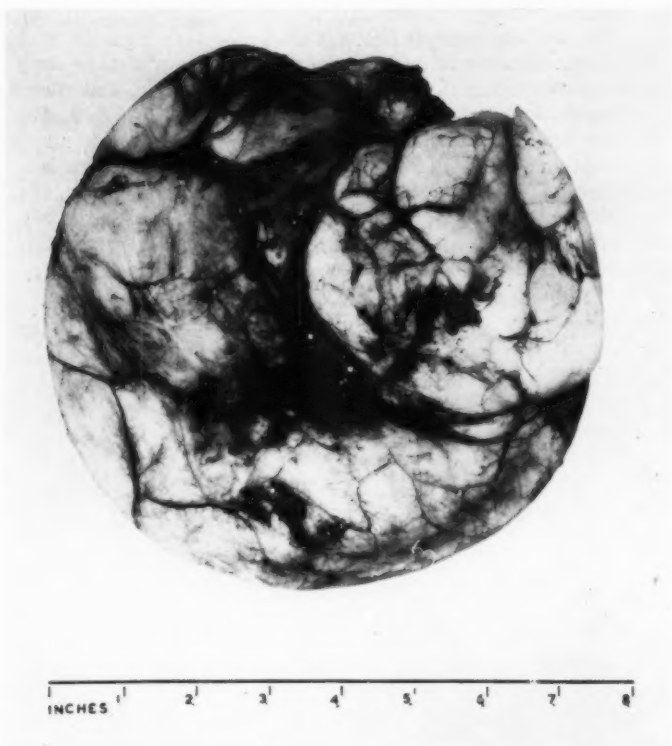
Fig. 11.   Macroscopic appearances of the lipoma shown in Fig. 10.

A few neurofibromata, and especially those discovered in children, are malignant from their inception.   Some of these are quickly fatal and no treatment is of avail, whilst others most surprisingly are cured by excision —thus it is rash to give a prognosis in these cases, and excision is always justified if the operation is technically possible.   Radiotherapy and chemotherapy are of no avail.

Von Recklinghausen's disease can also involve intercostal nerves (Fig. 12).   Most cases of typical neurofibromatosis do not do so ; but some occur in which the superficial tumours are lacking whilst the intercostal nerves (and also the nerves in the base of the neck) are plexiform.   If a

388

patient has " café au lait " spots, or superficial neurofibromata and multiple X-ray opacities in the chest wall, the diagnosis is certain. There are two reasons to differentiate these cases from solitary neurofibromata ; the first that it may not be practicable to excise the intercostal lumps ; the second that sarcomatous change occurs in Von Recklinghausen's disease

Fig. 12. This patient suffered from Von Recklinghausen's disease, and the tumours in this photograph were removed from the intercostal nerves on one side of the chest. They were neurofibromata. It is not unusual for multiple neurofibromatosis to affect the intercostal nerves and in some cases the tumours become sarcomatous. The common neurological tumours in the chest are solitary neuromata which do not often become malignant.

and is untreatable. Some of these malignant growths occupy most of a hemithorax and become indistinguishable from sarcomata derived from the intercostal muscles or parietal connective tissues. By comparison with solitary neurofibromata, Von Recklinghausen's disease in the chest wall is a difficult and dangerous curiosity.

The last group of primary tumours are those that originate in the ribs ; these are said by some to comprise about 10 per cent. of all bone tumours. Tumours growing from the sternum, the vertebrae or the diaphragm are rare.

One might have expected that *osteoma* would be the starting point of a discussion on this subject. Cancellous osteoma does occur ; but is rare and unimportant. The point to understand is that rib tumours, that often contain bone, are not derived from bone. Practically all are cartilagenous at source, and they grow from any part of the rib and not from the costo-chondral junctions or the epiphyses.

389

Osteochondromata, or exostoses, are slightly more common than osteomata (Fig. 13). Two varieties, which are different, exist. The first are true exostoses; they are small tumours that sprout like mushrooms from any part of the shaft of a rib. A bursa, that can be large and the presenting factor, caps the excrescence and may protrude from under the scapula. These tumours contain bone, marrow and a cap of cartilage. Growth is said to stop when the bone becomes adult, and they may need local excision. Recurrence or malignant change need not be anticipated.

Fig. 13a. At the age of eight weeks this child, who is now aged three years, fell off a chair and is said to have injured the lower part of the right chest. The fall was not seen; but shortly afterwards the mother noticed a lump to be growing at the place where the tumour now is. Apart from the obvious deformity, the child was healthy and symptomless. There were no other bony abnormalities.
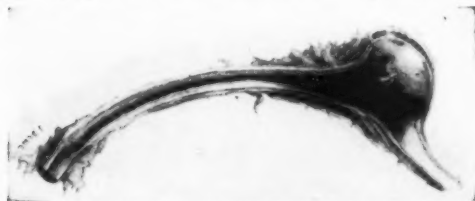
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Fig. 13b. A painting of the cut surface of the tumour. This shows that, although it is immediately adjacent to the costal cartilage, the mass is separate from the normal cartilage. The tumour is an osteo-chondroma of rib.

The second variety occurs as a part of *diaphysical aclasis*. The exostoses growing from the ribs can be large and, if multiple, can so deform the chest as to make respiration difficult. These tumours look like chondromata on X-rays, but they do not have the same inclination to malignant change as the primary cartilagenous tumours. They may require excision for cosmetic purposes, to relieve pain or progressive scoliosis.

The *cartilagenous tumours* of rib are the commonest new growths of rib.

The aetiology is unknown but a proportion date from an injury; in such the patient usually complains of pain that persists after the injury and a tumour ultimately develops at the spot. The fact that fibrous dysplasia may also be due to trauma is no more than a point of similarity between these two different conditions.

The pathology is difficult because the differences between benign and malignant areas histologically are slight. Indeed the most malignant tumours are often relatively acellular, and the final verdict is apt to be left to the surgeon who finds invasion or metastases. It is said that whatever they look like, 50 per cent. of the cases are malignant when the patient is first seen.

A chondroma grows from any part of a rib and not from the costal cartilages. The rate of growth varies in different tumours and in the same tumour at different times. They may remain stationary and unchanged for years, only to embark upon sudden and rapid progress for no apparent reason.

On section the structure is of lobulated cartilage. But there are areas of degeneration, including mucous and haemorrhage; calcification is usual and islets of abnormal bone occur throughout the tumour. In some places there are papilliferous tissues consisting of soft cartilagenous cells that break off.

The radiographs show complete disorganisation of the rib, or ribs, concerned and the consistency of the shadows depend upon the calcium content of the lump.

The clinical signs vary. Some chondromata are silent, some painful. Some produce symptoms due to invasion of adjacent structures or distant metastases in the lungs, the liver, or other viscera. In general the well-being of the patient is not adversely affected until sarcomatous changes have occurred, but a hopeless case may be symptomless. The volume of the tumour (Fig. 14) that is palpable, is often but a poor indication of the whole, and every structure in the thorax may be implicated by direct extension and invasion.

Many clinicians take a calm view of chondroma of rib. But those who realise the grim potentialities will advise excision at the earliest possible moment. The fact that part of the chest wall must be sacrificed is no contraindication to radical surgery.

391

N. R. BARRETT

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PRIMARY SARCOMA OF RIB

Fig. 14. Painting of the cut surface of the specimen. Note the following points : The abnormal process extends for some distance along the shaft of the rib. The tumour is composed of a variety of different types of tissue : in some places it is formed of benign cartilage, in others it is cystic, and the haemorrhagic areas are frankly malignant. It was impossible at operation to say more than that it was a cartilaginous growth which could be removed. Histologically it proved to be a chondrosarcoma. The patient died from metastases two years after excision of this tumour.

Benign and malignant tumours recur unless excision is radical. No other treatment is of avail. Recurrences occur in any part of the affected rib that has not been taken away, or in the chest wall musculature or the pleural cavity in which a friable seedling has been planted at the first operation. Radical excision means taking away not only the tumour and anything to which it is attached, but the whole of the rib or ribs involved and the intercostal structures for one clear space on either side of the lesion.

VALE

I hope to have illustrated the wide scope of this subject. As your practical experience increases you will find these cases more numerous than you may now suspect. They are difficult to diagnose but one hopes not to make the same mistakes too often, and by gathering information to provide better treatment.

REFERENCES.

The reader will find a bibliography covering Primary Tumours of Rib and allied topics in an article in the *British Journal of Surgery* 1955, **43**, 113. In this paper there are also many additional illustrations.

RECENT OVERSEAS VISITORS TO THE COLLEGE

RECENT OVERSEAS VISITORS to the College have included Dr. F. Djorup and Dr. K. E. Petersen of Denmark and Dr. K. Carter and Dr. W. Compton of the United States of America, all of whom attended the Monthly Dinner in November.

392

THE THOMAS VICARY COMMEMORATION

THIS COMMEMORATION WAS held on 30th October, when the Thomas Vicary Lecture was delivered in the Great Hall by Sir John McNee, M.D., F.R.C.P., F.R.S.(Ed.), Past-Master of the Worshipful Company of Barbers.

The same evening the Council were entertained at dinner by the Court of the Barbers' Company in Armourers and Brasiers Hall.

Mr. H. R. Thompson, F.R.C.S., Upper Warden of the Company, proposed the toast of the College and the Thomas Vicary Lecturer in a speech of great interest. He mentioned that the Company and the College, different as they were, had the common link of providing new interests. Not only had Sir John McNee broken fresh ground on the history of provincial Barber-Surgeons, but he himself while on a visit to the Duke of Sutherland's private museum at Dunrobin Castle had discovered a medallion inscribed with the names of James Paget and Erasmus Wilson which had been given to an earlier Duke of Sutherland in exchange for an Egyptian Mummy with an abnormal number of vertebrae —presumably for the College Museum. Mr. Thompson paid tribute to the many distinctions and great services of the President of the College, Sir James Paterson Ross, whose election to that office had given such wide-spread satisfaction. He then acclaimed Sir John McNee for his memorable lecture and described him as belonging to " a group of speakers whom I recognise as spellbinders."

Sir James Paterson Ross expressed thanks to the Upper Warden for his delightful speech ; to the Company for their welcome and hospitality, a pleasant taste of gracious living ; to the singers for their beautiful Grace and other music ; to the Company for displaying the authentic silver, for providing the lecture and its association with this delightful meeting, and for its place in the good influence and charitable generosity of the City of London.

Sir John McNee said how grateful he was to the College for the honour of being appointed Thomas Vicary Lecturer, in which post he was glad to follow such another physician as Cecil Wall. He had had a long interest in the Royal College of Surgeons and had been able in the first World War to obtain many specimens illustrating gas gangrene for its museum.

The admirable music was provided by the St. Paul's Singers, a quartet composed of lay clerks from the Cathedral, who sang not only Grace but also two groups of part songs, including madrigals, a negro spiritual and such old favourites as " When evening's twilight " and " The owl and the pussy cat."

Finally Mr. Lucas, the Hall Keeper, gave a most interesting talk on the suits of mail and other armour with which the walls of the Hall are liberally decorated. The collection, necessarily antique for the most part, is brought up to date by the inclusion of some modern bayonets.

A RECENT ADDITION TO THE COLLEGE TREASURES

HER ROYAL HIGHNESS The Princess Royal was elected to the Honorary Fellowship of the Royal College of Surgeons of England on 13th January 1927, when she was Princess Mary, Viscountess Lascelles, and on 14th February she came to the College to be admitted to the Fellowship and to attend Sir Berkeley Moynihan's Hunterian Oration. Those who were there will remember the opening words of his Oration—" May it please Your Royal Highness, our most Junior Fellow . . . "
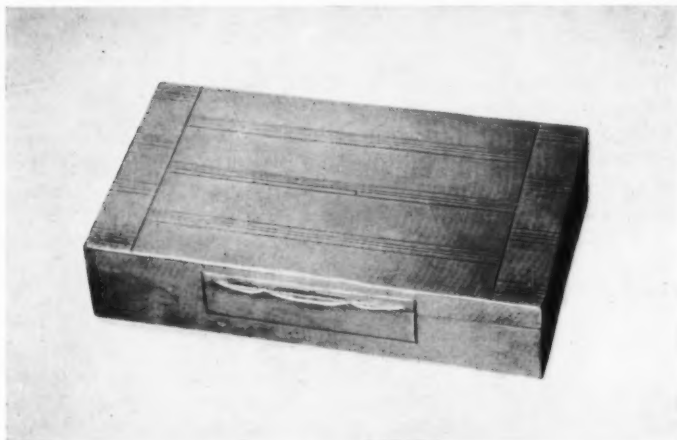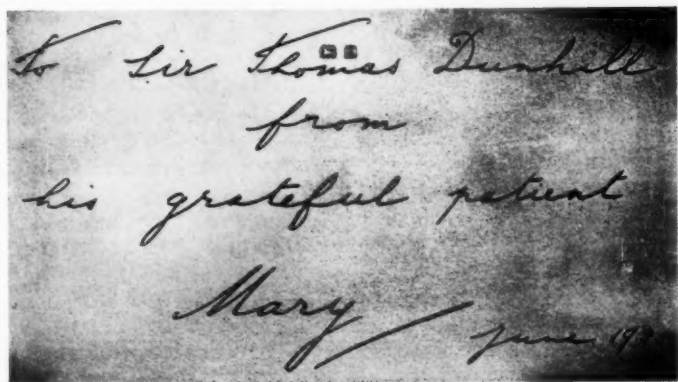
The silver cigarette box presented by Her Royal Highness The Princess Royal to Sir Thomas Dunhill in 1935.

In 1935 Her Royal Highness underwent an operation for goitre, and among the most prized possessions of the late Sir Thomas Dunhill was the silver cigarette box which she gave him as a memento of that event. Sir Thomas himself was elected to the Honorary Fellowship in 1939, and after his death last December his executors came to the very kindly decision that the rightful place for the box would be the College. The Princess Royal graciously gave her consent to this suggestion and Miss Mary Macdonald brought the cigarette box to the College when she attended the monthly dinner on 11th June and handed it over to be added to our treasures.

The President and Council are deeply grateful to the Executors for their kindly thought, and to Her Royal Highness for graciously agreeing to their suggestion that her gift should find a resting place in the College where it will ever be treasured as a memento of two of our Honorary Fellows.

The inscription on the inside of the cigarette box.

THE ROYAL COLLEGE OF SURGEONS AND IMPERIAL CANCER RESEARCH FUND

Preliminary Contract. Underpinning and Demolition.*

WORK ON THIS preliminary contract has been started and is progressing well. It affects the College west wall and will in due course enable the builders to demolish Nos. 44, 45 and 46, Lincoln's Inn Fields.

It should be noted that while the preliminary sketch plans for the new Fund building were being prepared, authority was given to sink a series of trial holes to prove once again the type of soil on which the building will rest. Previous information concerning the Royal College site showed many variations of soil, and much made-up ground was found at the higher levels, then clay and water, then the London blue clay, and below that good gravel.

The main trial hole was sunk immediately against the west wall of the College at the north-west corner. When the base of this main wall was reached, it was discovered that there was no concrete under the brickwork, the wall resting on the ground. It was also discovered that a part of this wall had been partly underpinned in concrete. Unfortunately, this underpinning had not been very cleverly done as the main mass of the concrete was not directly under the centre of the wall above. This has proved a great nuisance when designing and constructing the new thick retaining wall now being prepared for. The district surveyor insists that

*The following article is condensed from notes provided by Mr. Alner Hall, the Consulting Architect for the Scheme.

395

the foundations for the new Imperial Cancer building must rest on t e gravel below the bed of blue clay, and this has necessitated a very de p excavation. The bottom level will be about thirty-three feet below t e basement floor of No. 44, Lincoln's Inn Fields.

With this information made available to the consulting enginee s a detailed scheme for stabilizing the west wall of the College was prepared, taking into consideration at the same time the future construction of the east wall of the Fund building.

It was agreed that as this additional depth was inevitable, advantage should be taken to plan for a sub-basement over the whole of the Imperial Cancer site.

At the same time that this foundation problem was being tackled, another equally difficult one came to light, which had to be solved. When the upper parts of the College were built the main walls were carried on deep reinforced concrete beams, resting at their west end on the old west wall of the College. Calculations showed that this west wall, which is really two separate walls, the western-most being the old wall of No. 44, was overloaded.

To get over these difficulties the consulting engineers have designed a scheme, approved by the district surveyor, of inserting three eighteen inches by eighteen inches reinforced concrete stanchions cut into the old wall; two of these stanchions will run up the height of the building stopping immediately under the main beam and spreader carrying the upper floors of the College. The third stanchion stops short under a subsidiary beam at a lower level. This work has to be done in two stages, and when complete and the stanchions tied together with short lengths of existing beams at different levels, the old walls can be removed and new nine inch walls built from the top downwards. This is much the same method that was adopted in the case of the rebuilding of the east wall of the College.

All this work is proceeding satisfactorily, but is presenting considerable difficulties. The size of the first hole is about twelve feet by ten feet, and pumping of mud and water has to be done to give reasonable conditions for the men in the hole.

As soon as the first two stanchions are completed it will be possible to begin on the stabilizing of the east wall of No. 47, Lincoln's Inn Fields, and this will be followed by demolition of the three houses, Nos. 44, 45 and 46.

The builders expect to complete their contract by 31st March 1959.

TRUSTEES OF THE HUNTERIAN COLLECTION

AT THEIR MEETING in October, the Trustees elected Sir Cecil Wakeley, Bt., to the Board to fill the vacancy occasioned by the death of Lord Webb-Johnson.

In Memoriam

ROBERT OFFICER, F.R.C.S., F.R.A.C.S.

1906-1958

IT IS WITH profound regret and with a deep sense of personal loss that we have to record the death of Mr. Robert Officer of Melbourne. The following note has been contributed by Mr. W. B. Gabriel :

" News of the recent sudden death in Melbourne of Robert Officer has come as a great shock to all of us at St. Mark's Hospital. Bob Officer worked at St. Mark's in 1936 and was one of a long list of first-class R.S.O.s from the Antipodes, all of whom, both before and since, have done well and have distinguished themselves in surgery. Although a long time has gone by it is true to say that no name is so often mentioned at St. Mark's as Officer's, and we speak of him daily because of two pieces of apparatus which he devised. He was the inventor of a two-way transfusion drip bulb which has been in constant use for over twenty years ; it has proved a wonderful piece of equipment which must have been instrumental in saving hundreds of lives of major operation cases. I never lose an opportunity of pointing out this item to visitors to our theatres and I know that it has been greatly admired. There is also a neat little toothed dissecting forceps which bears Officer's name and this has been in routine use in the out-patients' department and the operating theatres ever since he worked at St. Mark's. Robert Officer, while R.S.O. at St. Mark's, became very interested in the technique of haemorrhoidectomy and was a part author of an important paper published in the *Lancet* in 1937, which introduced a modification of Salmon's ligature operation and this has been current practice ever since.

"After returning to Australia, Officer was appointed to the Staff of the Alfred Hospital and became one of the leading surgeons in Melbourne. Those of us who knew him here in the past remember his sterling qualities ; we grieve over his loss and extend our very real sympathy to his family, his colleagues and his patients in Melbourne."

Mr. C. Naunton Morgan, another colleague of Mr. Officer's while the latter was at St. Mark's Hospital, writes :

" The untimely death of Bob Officer has deeply grieved his many friends in the British Commonwealth. The loss to surgery is a great one and his wise and carefully considered counsel will be greatly missed by both the Royal Australasian College of Surgeons and by his colleagues at the Alfred Hospital. In addition to having had the pleasure of being associated with him at St. Mark's Hospital, where he will always be fondly remembered for his good work and comradeship, I had an opportunity of meeting him as a soldier at war in the Middle East. When on a visit to Melbourne later, almost at once he insisted that I should meet his friend and mentor, Fay Maclure. The sterling qualities of this man have been reflected in Bob Officer's life as a man and a surgeon— an epitaph that he would have desired."

Mr. J. C. Stewart, who was a colleague of Mr. Officer's at the Alfred Hospital, Melbourne, writes :

" Robert Officer was a man who dedicated his life to surgery. Born in Perth, Western Australia, in 1906, he was the elder son of Dr. Edward Officer. His early life was spent in Perth where he was educated at Hale School. As there was

397

no Medical School in Western Australia at that time, he came to Melbourne University to do his medical course and during that time was a resident of Ormond College. Of large, powerful physique, he was an outstanding athlete and won a Triple Blue in football, rowing and athletics.

" Graduating in 1931, he became first a resident medical officer and then a registrar at the Alfred Hospital. It was there that he came under the influence of one of Australia's great surgeons, the late Fay Maclure, to whom his basic qualities of an unlimited capacity for hard work and a conscientiousness in the care of his patients greatly appealed. Fay Maclure became his mentor and lifelong friend.

" Postgraduate studies took him to England in 1934, and in 1937 he became a Fellow of the Royal College of Surgeons of England. The following year was spent as a resident medical officer at St. Mark's Hospital, where his work on the aftercare of post-operative cases earned him the gratitude of the Honorary Medical Staff of that hospital.

" On returning to Australia in 1939, he became an Associate Surgeon at the Alfred Hospital for a brief period before enlisting in the A.A.M.C. at the outbreak of war. He was made a Fellow of the Royal Australasian College of Surgeons the following year, and proceeded overseas with the 2/1 C.C.S. His war career was distinguished and varied, as, apart from his surgical work, he was connected with two major pieces of research, first into the problems of blood storage, and secondly into the uses of penicillin, when supplies of that drug first became available.

"At the end of the war in 1946, he became Surgeon to In-Patients at the Alfred Hospital and was associated in practice with Fay Maclure. An impressive teacher and always keenly interested in undergraduates, he became Sub-Dean of the Alfred Hospital Clinical School in 1948, and held that office until 1957, when he became Dean of the School.

" His association with the Army Medical Services continued after the war, and in 1948 he was posted as Consultant Surgeon to the Australian Army Medical Corps. In 1950 he was made Honorary Surgeon to His Excellency, the Governor General, and in 1953 he was honoured by being made Honorary Surgeon to Her Majesty The Queen, just prior to her visit to this country. His integrity as a man and his high standard of professional skill and conduct made him sought after as a leader in his profession, and in 1946 he was elected to the Victorian State Committee of the Royal Australasian College of Surgeons. In 1955 he became a member of the Council of that body.

" During the war he married Adele Catford, and his wife and two daughters were the only absorbing interest in his life outside his work. Essentially a family man, it was always his great regret that his work left him so little time to spend in his home. Bob Officer was a quiet man who was not easy to know well, but to his friends and his hospital he gave a loyalty that never wavered. He held a high place in the community, both as a man and as a surgeon, and his premature death is a great loss to the medical profession of this country."

Professor John Loewenthal of Sydney, who was his colleague as a Consulting Surgeon to the Australian Army, and his intimate friend, has sent us the following appreciation :

" In Australia the surgical community is a particularly close-knit one, as is perhaps to be expected since it is predominantly British in origin and the distances between the main centres though great by European standards are comparatively small by local ones. The comradeship of the surgeons in the country has been welded in Expeditionary Forces which were, until the latter part of the Second World War, completely volunteer. In addition, the majority

398

cf surgeons now practising in the country had at some stage trained in the United Kingdom. As a result the interest of individual members of our surgical community in each other has always been considerable.

" In this closely woven fabric of Australian surgeons the sudden death of Robert Officer of Melbourne has torn a gaping hole. Throughout the entire Commonwealth of Australia he was known both in war and peace as one of the men who was now fulfilling his promise and bringing great and deserved prowess to our surgery. We remembered how before the war he had worked at St. Mark's Hospital and developed the " Officer Drip," which had such a profound influence in reducing the mortality of the classical abdomino-perineal resection of the rectum. In that great hospital he left his mark as a man of immense ability and skill who worked tirelessly and with a singleness of purpose and forcefulness which brooked neither interference nor unwarranted intervention.

" When the war broke out, these qualities impelled him to enlist early in the course of hostilities and to be moved into the Western Desert to take part in the first major victory at Bardia as a surgeon in the 2/1 Australian Casualty Clearing Station. Here with characteristic vigour he organized, directed and worked and subsequently applied the lessons learnt to good advantage during the campaign in Syria. Later, on return to Australia in the dark days of 1943, he became the head of a research team to develop the clinical and service applications of penicillin. Finally he was appointed Consulting Surgeon to the Australian Military Forces in 1946 and held this post until his death.

" Following the war he resumed both his appointment at the Alfred Hospital and his civil practice. This was in association with Fay Maclure, the man who had influenced him more than any other single individual. Maclure was a man of infinite skill and kindliness, a person without an enemy and with a myriad of admirers. Bob Officer was to him as a son and the association between the older and younger man was one of those splendid things that happens in the conduct of surgery—an association which only develops between men of quality and which exemplifies human endeavour at its finest. Within a brief time he acquired a consulting practice in Melbourne befitting his talent and skill.

" In every way he was a big man. Physically he gave the impression of great strength and determination and mentally he was able to transmit to those who came to him for help and advice some part of the enormous power which his quiet, thoughtful skill made possible.

" For many months he had not been well and was aware of the fact that his life was unlikely to be a long one. He went about his business unobtrusively and meticulously as ever, and in full spate his life ended. He would not have wanted a lengthy or flowery obituary—rather would he have had his friends think of him as he was, strong and courageous, hating the cheap and specious, seeking constantly truth and honesty, single of purpose, clean and incisive of judgment, a master surgeon and a gentleman in the finest of our traditions."

MEDICAL FACULTY OF THE UNIVERSITY OF THE PUNJAB

PROFESSOR S. SINGH ANAND, F.R.C.S., Professor of Surgery at Amritza, has been appointed Dean of the Medical Faculty of the University of the Punjab. He has also been elected President of the Association of Surgeons of India for the ensuing year.

CENTENARY OF THE FIRST PUBLICATION OF GRAY'S ANATOMY

A VERY PLEASANT dinner was held at Stationers' Hall on the 18th September 1958 to celebrate the centenary of the first publication of Gray's Anatomy. Mr. William Longman was in the Chair and proposed the toast of the editors of Gray's Anatomy. Professor T. B. Johnston, the senior editor replied.

A large number of anatomists and surgeons interested in the teaching of anatomy were present.

In 1845, at the age of eighteen, Henry Gray became a student at St. George's Hospital in London, where he became known as a painstaking and methodical worker who made a point of learning his anatomy by making dissections for himself.

A group at the Centenary Dinner. Left to right : Professor H. A. Harris ; Sir Cecil Wakeley ; Professor T. B. Johnston ; Sir Heneage Ogilvie ; Professor D. V. Davies.

He soon began to show promise of brilliance, and at the age of twenty-five he was elected a Fellow of the Royal Society. In 1861 he was a candidate for the post of assistant-surgeon at St. George's, when he unfortunately contracted smallpox and died at the early age of thirty-four.

In 1858 the first edition of his Anatomy was published. It contained 750 pages and 363 figures, and cost 28s. The book was an immediate success and Gray prepared a second edition which was published in 1860.

The centenary edition or the thirty second edition is edited by Professors T. B. Johnston, D. V. Davies and F. Davies and contains 1,604 pages and 1,329 illustrations of which 657 are coloured and 50 are X-ray plates.

It is given to few text-books to live and retain their popularity and usefulness for a hundred years and Messrs. Longmans Green and Company are to be congratulated on their achievement.

PROCEEDINGS OF THE COUNCIL IN NOVEMBER

AT A MEETING of the Council on 13th November, with Professor Sir James Paterson Ross, President, in the Chair, the John Hunter Medal was presented to Dr. L. W. Proger.

D. A. Warrell, of the Portsmouth Grammar School, was admitted as Macloghlin Scholar.

Dr. L. W. Proger receiving the John Hunter Medal from the President, watched by Sir Archibald McIndoe and Mr. A. Dickson Wright, Vice-Presidents.

Sir Clement Price Thomas was appointed as Tudor Edwards Memorial Lecturer and Mr. Michael Smyth as Gordon-Watson Lecturer.

Lord Cohen of Birkenhead was appointed as the first Watson-Jones Lecturer.

The election of Sir Cecil Wakeley, Bt., as a Trustee of the Hunterian Collection was announced.

The Begley Prize was awarded to Miss M. E. Ashworth of Charing Cross Hospital Medical School.

Diplomas of Membership were granted to 136 candidates, and Licences in Dental Surgery were granted to 85 candidates.

· A diploma of Fellowship in the Faculty of Anaesthetists was granted to one candidate, and a diploma in Orthodontics was granted to one candidate.

The following diplomas were granted, jointly with the Royal College of Physicians: *Ophthalmology* (1): *Child Health* (2); *Industrial Health* (1).

The following hospitals were recognized under paragraph 23 of the Fellowship Regulations:

HOSPITALS	POSTS RECOGNISED		
	General (all 6 mths.)	Casualty (all 6 mths.)	Unspecified (all 6 mths.)
NEATH—General Hospital (Additional)			*Under para.* 23 (c) E.N.T. Regr. E.N.T. H.S.
BRIDGEND — General Hospital (Additional)			*Under para.* 23 (c) E.N.T. S.H.O.
COLCHESTER — Essex County Hospital (Redesignation)		*Redesignation of* S.H.O. (Cas. & E.N.T.) *as* Regr. (Cas. & Orth.)	
PRESTON — Royal Infirmary (Additional)			Orth. S.H.O.
LONDON — Wanstead Hospital (Redesignation)	R.S.O. S.H.O. (Deputy R.S.O.) H.S.	S.H.O. (Cas. & Orth.)	
WORKSOP — Victoria Hospital (Additional)	S.H.O.		
CYPRUS—British Military Hospital, Nicosia		Recognition transferred to British Military Hospital, Dhekelia.	

Lt.-Colonel R. H. Robinson being congratulated by the President after receiving the Mitchener Medal from Lt.-General Sir Alexander Drummond (as reported in the November issue of the ANNALS).

APPOINTMENT OF FELLOWS AND MEMBERS
TO CONSULTANT POSTS

J. N. ASTON, F.R.C.S.	Consultant Surgeon to Orthopaedic Dept., St. Bartholomew's Hospital.
R. E. MOLLOY, M.B., L.R.C.P., F.F.A.R.C.S.	Consultant Anaesthetist to Whittington Hospital.
E. J. D'ARCY, M.C., M.R.C.S., F.F.A.R.C.S.	Consultant Anaesthetist to Maidenhead, Canadian Red Cross Memorial and Upton Hospitals.
R. W. McNABB, M.R.C.S., D.M.R.D.	Consultant Radiologist to West Herts & St. Paul's Hospitals.
J. S. CONWAY, F.R.C.S., D.O.M.S.	Consultant Ophthalmologist to New End Hospital.
JOSEPHINE J. CANDY, M.B., F.F.A.R.C.S.	Consultant Anaesthetist to King Edward Memorial, Perivale Maternity, Brentford, Acton and Southall-Norwood Hospitals.
V. EDMUNDS, M.D., M.R.C.P., M.R.C.S.	Consultant Physician to Mount Vernon Hospital.
HILDA M. S. DAVIDSON, M.B., L.R.C.P., D.P.M., M.R.C.S.	Consultant Psychiatrist and Medical Director to Child Guidance Training Centre.

The Editor is always glad to receive details of new appointments obtained by Fellows and Members, either through the Hospital Boards or direct.

COLLEGE PUBLICATIONS

READERS ARE REMINDED that the following publications issued or sponsored by the College may be obtained from the Editorial Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2.

Lives of the Fellows, 1930-1951. By the late Sir D'Arcy Power, K.B.E., F.R.C.S., Honorary Librarian, and continued by W. R. Le Fanu, M.A., Librarian. A single volume, bound in blue cloth, of 889 pages, containing the Lives of all Fellows known to have died between 1930 and 1951. £2 2s. 0d. post free.

A Record of the Years from 1901 *to* 1950. Edited by Sir Ernest Finch, M.D., M.S., F.R.C.S. A slim volume, illustrated, containing a brief history of the College between the centenary and the 150th anniversary of the foundation with lives of all the Presidents since 1900, written by special contributors from their personal knowledge. In red cloth 9s. post free or red paper covers 5s. 6d. post free.

John Hunter, a List of his Books. A short-title bibliography of all known editions of John Hunter's books, compiled by the Librarian. Printed at the Cambridge University Press, and bound in green cloth. 2s. 6d. post free.

A Guide to the Hunterian Museum (*Physiological Series*). This gives a brief account of the physiological section of John Hunter's museum, the scope, design and historical value of which is unique. 48 pp. 1s.

A Descriptive and Historical Catalogue of the Darwin Memorial at Down House. Charles Darwin and his family lived at Down House, near Orpington, Kent, for forty-two years and it was here that most of his scientific investigations were made, including his work on the Origin of Species, published in 1859. 33 pp. 1s.

The Portraiture of William Harvey. The Thomas Vicary Lecture for 1948 by Geoffrey Keynes, M.A., M.D., F.R.C.S. With a descriptive catalogue and 33 reproductions of the portraits. £1 5s. 0d.

**William Clift.* By Jessie Dobson, B.A., M.Sc., Anatomy Curator. A new biography, fully illustrated, of the first Conservator of the Museum at the College. Published by William Heinemann Medical Books Ltd. Bound in blue cloth ; 144 pages with frontispiece portrait and 31 plates. 8s. 6d. post free.

**A separate cheque for this publication would be appreciated.*

403

SAYINGS OF THE GREAT

" A life full of work and toil is not a burden but a benediction."

Rudolph Virchow (1821—1902)

" Ideas do not come from prosperity, affluence and contentment, but from the blackness of despair ; not in the light of day but from the quiet undisturbed hours of midnight or early morning when one is alone to think."

Frederick Banting (1891-1941).

" Those about to study medicine and young doctors also should light their torches by the fires of the ancients." *Carl Rokitanski* (1804-1878).

Contributed by Dr. S. B. van der Merwe.

Contributions are invited.

THE COLLEGE TIE

The design is a College crest (an eagle proper holding a mace of gold) repeated on a maroon background. The tie is made in pure silk or silk and rayon, and also available are squares in the same design and tubular scarves. These may be worn by the following : Fellows and Members of the College ; Fellows and Licentiates in Dental Surgery ; Fellows of the Faculty of Anaesthetists ; holders of the special diplomas granted by the Royal Colleges through the Conjoint Board ; postgraduate students attending educational courses at the College. The tie can be obtained from Messrs. T. M. Lewin & Sons Ltd., 1-3 Jermyn Street, St James's, London, S.W.1.

DIARY FOR DECEMBER

Wed. 17	5.00	Board of Faculty of Anaesthetists.
Thur. 18		Basic Sciences Lectures and Demonstrations end.
Fri. 19		Dental Lectures and Clinical Conferences end.
Wed. 24		College closed.
Thur. 25		Christmas Day. College closed.
Fri. 26		College closed.
Sat. 27		College closed.

DIARY FOR JANUARY

Thur. 1		D.I.H. Examination begins.
		Last day for nomination of candidates for election to the Board of Faculty of Anaesthetists.
Tues. 6		Final Membership Examination begins.
Thur. 8	2.00	Quarterly Council.
	5.00	Prof. R. A. Mogg—Hunterian Lecture—Congenital anomalies of the urinary tract in relation to disorders of micturition.*
Tues. 13		Final F.D.S. Examination begins.
Thur. 15	3.45	Dr. B. Cohen—Arnott Demonstration—Modern variations of John Hunter's madder feeding experiments.*
Fri. 16	5.00	Board of Faculty of Dental Surgery.
Thur. 22	5.00	Final F.F.A. Examination begins.
		Prof. J. W. Dickson—Hunterian Lecture—Pathological ossification in nervous disease with special reference to traumatic paraplegia.*
Mon. 26		Basic Sciences Lectures and Demonstrations begin.
Tues. 27	5.00	Dr. R. C. B. Pugh—Erasmus Wilson Demonstration—Problems in bladder pathology.*
Wed. 28		Primary F.R.C.S. Examination begins.
Thur. 29	5.00	Prof. J. S. Calnan—Hunterian Lecture—The surgical treatment of speech disorders.*

* Not part of courses.

404

INDEX TO VOLUME 23
JULY-DECEMBER 1958

The first number shows the monthly issue : the second number the page.

405